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EPA Industrial Boiler FGD Survey: Third Quarter 1978

PEDCo-Environmental, Inc, Cincinnati, OH

Prepared for

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16. ABSTRACT

The report presents detailed technical information concerning application of flue gas desulfurization (FGD) systems to industrial boilers. Design and operation data is presented for 161 FGD control systems (121 of them operational), designed to control SO2 emissions from 147 industrial boilers at 57 plants. With a 1978 capacity of 9.3 million scfm, an average of more than seven new FGD systems have been put on line each year since 1972. Information in the report was obtained by a survey of plant personnel, control system vendors, regulatory agencies, and consulting engineering firms. The data is given in two types of tables: one gives summary information; the other, detailed information. Summary tables present information as a function of control process, control system vendor, disposal technique, operational status, start-up date, and flue gas capacity. Detailed information includes: control system design, economics, operating experience, problems and solutions, waste disposal techniques, and maintenance practices.

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NOTICE

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Initial distribution of the report is limited to organization and individuals indicating a specific interest in the field of FGD technology. Additional copies of this report and succeeding issues can be purchased from National Technical Information Service, Springfield, Virginia 22151.

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EXECUTIVE SUMMARY

THE FIRST FULL-SCALE UNITED STATES APPLICATION OF FLUE GAS DESULFURIZATION (FGD) TECHNOLOGY TO INDUSTRIAL BOILERS WAS AT THE GENERAL MOTORS PLANT IN ST. LOUIS, MISSOURI WHERE TWO FGD SYSTEMS WERE INSTALLED ON TWO COAL-FIRED BOILERS IN 1972. IN THIS 3RD QUARTER 1978 REPORT, 121 OPERATIONAL FGD SYSTEMS ARE DESCRIBED. THESE SYSTEMS ARE CONTROLLING SO2 EMISSIONS FROM 165 BOILERS, LOCATED AT 39 PLANT SITES ACROSS THE UNITED STATES. FGD SYSTEMS AT 19 PLANTS ARE KNOWN TO BE UNDER CONSTRUCTION OR IN SOME STAGE OF PLANNING. IN ADDITION THERE ARE 6 INSTALLATIONS INCLUDED IN THE REPORT WHERE FGD OPERATIONS HAVE EITHER BEEN TERMINATED, INDEFINITELY SHUT DOWN, OR NEVER STARTED-UP. THE TOTAL COVERAGE OF THIS REPORT IS THEREFORE 64 INSTALLATIONS. TABLE I SUMMARIZES THE NUMBER AND SCFM OF THOSE SYSTEMS OPERATING, UNDER CONSTRUCTION, OR IN SOME PLANNING PHASE.

TABLE I
NUMBER AND SCFM OF INDUSTRIAL BOILER FGD SYSTEMS

STATUS	NO. OF INSTALLATIONS	CAPACITY SCFM	NO. OF SEPERATE FGD SYSTEMS	NO. OF BOILERS CONTROLLED
OPERATIONAL	39	5,040,760	121	165
UNDER CONSTRUCTION	10	1,836,750	33	107
PLANNING*				
CONTRACT AWARDED	2	266,000	4	5
LETTER OF INTENT	0	0	0	0
REQUESTING/EVALUATING BIDS	2	178,000	3	15
CONSIDERING USING FGD	5	1,924,000	4	16
TOTAL	58	9,245,510	165	308

*NOTE: THERE ARE PROBABLY SEVERAL FGD SYSTEMS BEING PLANNED WHICH HAVE NOT BEEN LOCATED BY THIS SURVEY AND THEREFORE ARE NOT COVERED IN THIS REPORT.

TABLE II SUMMARIZES THE PLANTS ACCORDING TO THE YEAR OF FGD STARTUP, AND THE SCFM CAPACITY.

TWO ADDITIONAL SECTIONS ARE PRESENTED IN THIS QUARTERLY UPDATE; SECTION 13, "INDUSTRIAL BOILER FGD COSTS," AND SECTION 14, "PROCESS DIAGRAMS FOR INDUSTRIAL BOILER FGD SYSTEMS."

SECTION 13, WHICH BEGINS ON PAGE 135 PRESENTS CAPITAL AND OPERATING COSTS FOR THE VARIOUS FGD INSTALLATIONS. IT IS IMPORTANT TO NOTE THAT THESE ARE REPORTED COSTS AND HAVE NOT BEEN ADJUSTED IN ANY MANNER. INCLUDED IS A DESCRIPTION OF THE ITEMS COVERED WITHIN THE COST FIGURES.

SECTION 14, WHICH BEGINS ON PAGE 146, PRESENTS PROCESS DIAGRAMS WHICH ARE STANDARDIZED IN FORMAT AND SYMBOLS; ALSO INCLUDED ARE EQUIPMENT LISTS, AND STREAM-FLOW CHARACTERISTIC TABLES TO PROVIDE A BETTER DESCRIPTION OF THE VARIOUS SYSTEMS.

HIGHLIGHTS FROM THE CURRENT INDUSTRIAL BOILER SURVEY ARE GIVEN BELOW:

TABLE II
STARTUP YEAR AND SCFM OF INDUSTRIAL BOILER FGD SYSTEMS

YEAR	UNITS	SCFM
1972	1	64,000
1973	4	621,300
1974	6	503,630
1975	12	1,473,300
1976	6	1,024,530
1977	4	342,000
1978	13	2,430,750
1979	5	596,000
1980	1	236,000
1982	1	320,000
1983	1	1,200,000
1987	1	280,000
YEAR NOT YET DETERMINED	3	154,000
TOTAL	58	9,245,510

THE ALYESKA PIPELINE SERVICE CO. FMC SODIUM HYDROXIDE SO2 CONTROL SYSTEM CONTINUED TO DEMONSTRATE A 100% AVAILABILITY INDEX. IT IS IMPORTANT TO NOTE THAT THE SYSTEM IS SUPPLIED WITH 100% REDUNDANCY (1 MODULE ON-LINE, 1 MODULE SPARE AT ALL TIMES). THE MILD CORROSION WHICH WAS OCCURRING IN THE DUCTWORK DOWNSTREAM OF THE ABSORBER HAS BEEN BROUGHT UNDER CONTROL BY CYCLOHEXAMINE SPRAYS.

AMERICAN THREAD PLANS TO REMOVE THE FGD I.D. FAN AND UPGRADE THE BOILER I.D. FAN. FAN IMBALANCE, CAUSED BY EROSION OF THE FIBERGLASS FAN LINER, HAS CAUSED VIBRATION CRACKS IN THE PVC PIPING.

CATERPILLAR TRACTOR CO. REPORTED THE FOLLOWING ITEMS FOR THEIR SEVERAL INSTALLATIONS:

EAST PEORIA - THE NEW FMC SYSTEM HAS BEEN RUNNING TROUBLE-FREE SINCE BOILER PLANT RESTART FOR THE FALL HEAT SEASON.

JOLIET - PROBLEMS ARE STILL IN EVIDENCE FOR THIS ZURN INDUSTRIES INSTALLATION, WITH RESPECT TO SHORT FILTER CLOTH LIFE AND PLUGGED, CORRODED, AND UNRELIABLE SO2 MONITORS. HASTELLOY C PROBES HAVE BEEN INSTALLED, BUT AS YET NOT EVALUATED.

MAPLETON - CONSTRUCTION OF FMC FGD SYSTEMS FOR THREE OF THE BOILERS IS NEARING COMPLETION. START-UP FOR THESE SYSTEMS IS SCHEDULED FOR OCTOBER 1978.

MORTON - ACCEPTANCE TESTING OF THE ZURN FGD SYSTEM IS SCHEDULED FOR LATER THIS YEAR.

CHEVRON U.S.A., INC. REPORTED THAT ONLY 2 OF THE FGD SYSTEMS WERE OPERATING, DUE TO LOWERED STEAM DEMAND. THESE 2 SYSTEMS CONTROL EMISSIONS FROM 12 STEAM GENERATORS. SYSTEM OPERABILITY INDEX FOR THE QUARTER WAS REPORTED TO BE 95%; THE ONLY PROBLEM HAS BEEN NA2CO3 FEED CHUTE PLUGGING, IN THIS KOCH ENGINEERING FGD SYSTEM.

DUPONT, INC. ANNOUNCED THAT LONG-RANGE FGD PLANS INCLUDE THE FOLLOWING:

IN TEXAS, A 160 MW (EQUIVALENT) SYSTEM SCHEDULED FOR START-UP IN 1982. DUPONT HAS DECIDED ON A LIMESTONE SCRUBBING STRATEGY FOR THIS SYSTEM, ALTHOUGH A VENDOR HAS NOT BEEN SELECTED.

IN GEORGIA, A 140 MW (EQUIVALENT) SYSTEM SCHEDULED FOR START-UP IN 1987. DUPONT HAS DECIDED THAT THIS WILL BE A DOUBLE ALKALI SYSTEM ALTHOUGH, AGAIN, A VENDOR HAS NOT BEEN SELECTED.

GENERAL MOTORS REPORTED THAT THE GM ENVIRONMENTAL-DESIGNED PARMA DOUBLE ALKALI FGD SYSTEM DEMONSTRATED A 100% OPERABILITY INDEX VALUE FOR THE THIRD QUARTER.

GETTY OIL IS EXPERIMENTING WITH A SILICON DISPERSANT TO ASSIST IN AMELIORATING SCALING PROBLEMS IN THE BLOWDOWN TANK OUTLET LINE FOR THIS FMC FGD INSTALLATION.

GRISSOM AIR FORCE BASE HAS ANNOUNCED THAT AIRPOL INDUSTRIES HAS TENTATIVELY BEEN SELECTED AS THE FGD SYSTEM SUPPLIER. THE SYSTEM WILL CONTROL 32,000 SCFM, FOR COAL WITH A SULFUR CONTENT RANGING FROM 0.9 TO 4.6%, AT A DESIGN RATE OF 1.2 LBS OF SO2/MM BTU HEAT INPUT. THE REPORTED EMISSIONS CONTROL SYSTEM COST IS 1.8 TO 2 MILLION DOLLARS.

ITT RAYONIER, INC. REPORTED THAT THE BOILER AND THE AIRPOL FGD SYSTEMS OPERATED APPROXIMATELY 95% OF THE PERIOD. THE ONLY OUTAGE DURING THE PERIOD WAS A 3-DAY DOWNTIME THAT WAS BOILER-RELATED.

KERR-MCGEE SODA ASH PLANT, UTILIZING A COMBUSTION EQUIPMENT ASSOCIATES DESIGN FOR SO2 REMOVAL, REPORTED TWO BOILER/FGD OUTAGES DURING THE QUARTER. BOTH OUTAGES WERE DUE TO THE NEED TO REPLACE SIEVE TRAYS IN THE ABSORBER MODULES. THE BOILERS ARE NOW BURNING 90-95% OF THE HIGH SULFUR MIXTURE OF COKE AND LOW-SULFUR WESTERN COAL.

MEAD PAPERBOARD CO. REPORTED AN AVAILABILITY INDEX VALUE OF 100% FOR THIS AIRPOL FGD SYSTEM FOR THE QUARTER.

THE MOBIL OIL DESIGNED SODIUM HYDROXIDE FGD SYSTEM AT THE SAN ARDO PLANT HAD AN ESTIMATED RELIABILITY INDEX VALUE OF 90%.

PHILIP MORRIS IN CHESTER, VIRGINIA, HAS PURCHASED A SODIUM CARBONATE FGD SYSTEM FROM FLAKT, INC.

THE SO2 REMOVAL SYSTEM WILL BE PRECEDED BY A COLD-SIDE ESP ALSO SUPPLIED BY FLAKT. THE SCRUBBER IS DESIGNED TO REMOVE 90% OF THE INLET SO2 FROM 2/3 OF THE FLUE GAS, ABOUT 30,000 SCFM; THE REMAINING 1/3 OF THE FLUE GAS WILL BE USED FOR REHEAT. START-UP IS SCHEDULED FOR JANUARY 1979.

RICKENBACKER AIR FORCE BASE REPORTED THEIR RESEARCH-COTTRELL/BAHCO SCRUBBER TO HAVE AN FGD SYSTEM AVAILABILITY INDEX OF BETTER THAN 99.9% FOR THE QUARTER.

AT THE ST. JOE ZINC CO. CONSTRUCTION IS NEARING COMPLETION; THE BUREAU OF MINES CITRATE PROCESS FGD SYSTEM IS NOW SCHEDULED TO START-UP IN DECEMBER 1978.

SECTION 1

INTRODUCTION

THIS REPORT ADDRESSES THE APPLICATION OF FLUE GAS DESULFURIZATION (FGD) TECHNOLOGY TO INDUSTRIAL BOILERS. AN INDUSTRIAL BOILER WILL BE DEFINED AS A BOILER OR STEAM GENERATOR WHICH IS OPERATING OR SCHEDULED FOR OPERATION AT AN INDUSTRIAL SITE. THIS IS IN CONTRAST TO A UTILITY BOILER WHEREIN THE PRIME FUNCTION IS STEAM GENERATION AND SUBSEQUENT CONVERSION TO ELECTRICAL POWER FOR SALE TO THE PUBLIC. THE NEED FOR SUCH A DOCUMENT HAS ARISEN AS A RESULT OF MORE STRINGENT EMISSION REGULATIONS DESIGNED TO REDUCE SULFUR DIOXIDE (SO2) EMISSIONS. IN VIEW OF THE DEVELOPMENTAL STATUS OF FGD TECHNOLOGY, EPA'S INDUSTRIAL ENVIRONMENTAL RESEARCH LABORATORY IN RESEARCH TRIANGLE PARK, NORTH CAROLINA, IS ESTABLISHING A PERIODICALLY UPDATED ENGINEERING APPLICATION/INFORMATION TRANSFER PROGRAM FOR INDUSTRIAL USE OF SO2 CONTROL TECHNOLOGY.

FIRST ISSUED IN DECEMBER 1977 AS A COMPREHENSIVE 900-PAGE REPORT ON SO2 CONTROL SYSTEMS ON ALL NONUTILITY COMBUSTION AND PROCESS SOURCES, THE CURRENT SERIES, IN THE INTEREST OF ECONOMIZING ON THE OPERATION, ADDRESSES ONLY INDUSTRIAL BOILER APPLICATIONS OF FGD TECHNOLOGY. THE FIRST ISSUE OF THIS SERIES, ENTITLED "EPA INDUSTRIAL BOILER FGD SURVEY: FIRST QUARTER 1978," PRESENTED DETAILED TECHNICAL INFORMATION ON INDUSTRIAL BOILER FGD INSTALLATIONS. THE INFORMATION WAS OBTAINED BY A SURVEY OF PLANT PERSONNEL, CONTROL SYSTEM VENDORS, REGULATORY AGENCIES, AND ENGINEERING FIRMS.

THE CURRENT REPORT REPRESENTS AN EXPANSION OVER THE SECOND QUARTER 1978 ISSUE WITH RESPECT TO BOTH THE NUMBER OF INSTALLATIONS, AND THE INFORMATION PRESENTED FOR EACH INSTALLATION. THE DATA ARE GIVEN IN TWO TYPES OF TABLES: ONE GIVES SUMMARY INFORMATION; THE OTHER DETAILED INFORMATION. SUMMARY TABLES PRESENT INFORMATION AS FUNCTIONS OF TYPE OF CONTROL PROCESS, CONTROL SYSTEM VENDOR, DISPOSAL TECHNIQUES AND OPERATIONAL STATUS (OPERATIONAL, UNDER CONSTRUCTION, PLANNED, OR NOT OPERATING). NUMBERS, OPERATIONAL STATUS, AND OVERALL CAPACITY OF THE FGD SYSTEMS ARE SUMMARIZED IN THE EXECUTIVE SUMMARY. DETAILED INFORMATION INCLUDES: CONTROL SYSTEM DESIGN PARAMETERS, OPERATING EXPERIENCE, ECONOMICS, PROBLEMS AND SOLUTIONS, WASTE DISPOSAL TECHNIQUES, AND MAINTENANCE PRACTICES.

THE INFORMATION IN THIS REPORT WILL BE PERIODICALLY UPDATED AND EXPANDED BY MEANS OF TELEPHONE AND MAIL SURVEYS, AND PUBLISHED EACH QUARTER. IN FUTURE ISSUES, THE DATA BASE ON SELECTED PLANTS WILL BE EXPANDED BY ON-SITE SURVEYS.

CERTAIN ENGINEERING SYMBOLS AND TERMS ARE USED VERY FREQUENTLY IN THE FIELD OF FGD TECHNOLOGY. TABULATED BELOW ARE THE DEFINITIONS OF PERTINENT SYMBOLS AND TERMS USED IN THIS REPORT.

SYMBOL/TERM	DEFINITION
ACF	ACTUAL CUBIC FEET, UNIT OF GAS VOLUME MEASURED AT ITS ACTUAL TEMPERATURE AND PRESSURE
ACFM	ACTUAL CUBIC FEET PER MINUTE, UNIT OF GAS FLOW RATE MEASURED AT ITS ACTUAL TEMPERATURE AND PRESSURE
AVAILABILITY	HOURS THE FGD SYSTEM WAS AVAILABLE (WHETHER OPERATED OR NOT) DIVIDED BY HOURS IN PERIOD, EXPRESSED AS PERCENTAGE
F	DEGREES FARENHEIT, UNIT OF TEMPERATURE

DEFINITIONS (CONTINUED)

SYMBOL/TERM	DEFINITION
F.D.	FORCED DRAFT
FRP	FIBERGLASS-REINFORCED POLYESTER (OR PLASTIC)
GAL	GALLONS
GPM	GALLONS PER MINUTE
I.D.	INDUCED DRAFT
L/G	LIQUID-TO-GAS RATIO, RECIRCULATING LIQUID FLOW DIVIDED BY THE ACTUAL GAS FLOW, GAL/1000 ACF
MM	MILLION (DOLLARS, GALLONS, BTU, ETC.)
MW(EQUIVALENT)	2000 SCFM/MW IS THE CONVERSION FACTOR USED FOR THIS REPORT. ALTHOUGH THERE ARE SEVERAL METHODS IN USE FOR ARRIVING AT EQUIVALENT MW, SUCH AS, LB/HR OF STEAM, MM BTU/HR OF HEAT INPUT, THE FACTOR MOST INFLUENTIAL IN AFFECTING EQUIPMENT SIZING IS FLOW RATE.
OPERABILITY	HOURS THE FGD SYSTEM OPERATED DIVIDED BY BOILER OPERATING HOURS IN PERIOD, EXPRESSED AS PERCENTAGE
PSIG	POUNDS PER SQUARE INCH, UNIT OF PRESSURE
RELIABILITY	HOURS THE FGD SYSTEM WAS OPERATED DIVIDED BY HOURS IT WAS CALLED UPON TO OPERATE, EXPRESSED AS PERCENTAGE
SCFM	STANDARD CUBIC FEET PER MINUTE, UNIT OF GAS FLOW RATE MEASURED AT 70 F AND 1 ATM. PRESSURE IF THE PRESSURE IS ASSUMED TO BE ONE ATMOSPHERE, THEN THE FOLLOWING RELATION EXISTS: SCFM = ACFM(460 + 70)/(460 + ACTUAL TEMP)
T	TEMPERATURE
W.G.	WATER GAUGE, UNIT OF PRESSURE DROP EXPRESSED AS INCHES OF WATER
0/XX	SYMBOL USED WHEN THE MONTH OF A STARTUP DATE IS NOT AVAILABLE
0/0	SYMBOL USED WHEN NEITHER THE MONTH NOR THE YEAR OF A STARTUP DATE IS AVAILABLE

THE ENGLISH SYSTEM IS USED IN THIS REPORT. SOME OF THE CONVERSION FIGURES BETWEEN THE ENGLISH AND METRIC SYSTEMS AND ABBREVIATIONS ARE SHOWN BELOW:

1 F (FOOT) = 0.3048 METER

1 T (SHORT TON) = 0.91 METRIC TON

1 LB (POUND) = 0.45 KILOGRAM

1 GAL (GALLON) = 3.79 LITER

1 BBL (BARREL) = 0.16 KILOLITER

1 SCFM = 1.58 NORMAL CUBIC METERS PER HOUR

1 GALLON/1000 ACF = 0.135 LITERS/NORMAL CUBIC METER

1 BTU = 0.25 KCAL

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SECTION 2

STATUS OF INDUSTRIAL BOILERS WITH FGD SYSTEMS

INSTALLATION NAME	LOCATION	START-UP DATE	STATUS*	PAGE NUMBER+
ALYESKA PIPELINE SERVICE CO.	VALDEZ, ALASKA	6-77	1	28(6,16,19,26,135)
AMERICAN THREAD CO.	MARION, NORTH CAROLINA	0-73	1	31(6,18,19,25,135)
ARCO/POLYMERS, INC.	MONACA, PENNSYLVANIA	6-80	3	118(6,16,23,24)
ARMCO STEEL	MIDDLETOWN, OHIO	0-75	1	33(6,17,19,25,135)
BELRIDGE OIL CO.	MCKITTRICK, CALIFORNIA	11-78	2	106(6,16,22, 0,135)
BELRIDGE OIL CO.	MCKITTRICK, CALIFORNIA	7-78	1	35(6,18,19,26,135)
BELRIDGE OIL COMPANY	MCKITTRICK, CALIFORNIA	6-78	1	36(6,17,19,26,136)
BUNGE, INC.	CAIRO, ILLINOIS	9-77	8	129(7,16, 0,24,136)
C.A.M.(CARBIDE-AMOCO-MONSANTO)	HOUSTON, TEXAS	10-83	6	120(7,18,23,27)
CANTON TEXTILES	CANTON, GEORGIA	6-74	1	37(7,16,19,25,136)
CARBORUNDUM ABRASIVES	BUFFALO, NEW YORK	0- 0	3	121(7,16,23,26)
CATERPILLAR TRACTOR CO.	EAST PEORIA, ILLINOIS	4-78	1	39(7,16,19,24,136)
CATERPILLAR TRACTOR CO.	JOLIET, ILLINOIS	9-74	1	41(7,18,19,24,136)
CATERPILLAR TRACTOR CO.	MAPLETON, ILLINOIS	10-78	2	107(7,16,22,24,137)
CATERPILLAR TRACTOR CO.	MAPLETON, ILLINOIS	10-79	2	109(8,17,22,24,137)
CATERPILLAR TRACTOR CO.	MORTON, ILLINOIS	1-78	1	43(8,18,19,24,137)
CATERPILLAR TRACTOR CO.	MOSSVILLE, ILLINOIS	10-75	1	45(8,17,19,24,137)
CHANSLOR WESTERN OIL & DEV. CO	BAKERSFIELD, CALIFORNIA	12-78	2	110(8,17,22,24,137)
CHEVRON U.S.A. INC.	BAKERSFIELD, CALIFORNIA	7-76	1	48(8,17,19,26,138)
CHEVRON U.S.A. INC.	BAKERSFIELD, CALIFORNIA	4-79	5	122(8,17,23,27)
DUPONT, INC.	GEORGIA	0-87	6	123(8,18,23,24)
DUPONT, INC.	TEXAS	0-82	6	124(9,18,23,24)
FIRESTONE TIRE AND RUBBER CO.	POTTSTOWN, PENNSYLVANIA	1-75	1	50(9,17,19,24,138)
FMC (SODA ASH PLANT)	GREEN RIVER, WYOMING	5-76	1	53(9,17,19,25,138)
GENERAL MOTORS CORPORATION	DAYTON, OHIO	9-74	1	55(9,16,20,25,138)
GENERAL MOTORS CORPORATION	PARMA, OHIO	3-74	1	58(9,17,20,24,138)
GENERAL MOTORS CORPORATION	PONTIAC, MICHIGAN	4-76	1	64(9,18,20,24,139)
GENERAL MOTORS CORPORATION	ST. LOUIS, MISSOURI	0-72	1	66(9,16,20,25,139)

* STATUS CODES

0 - STATUS NOT DEFINED	5 - PLANNED-REQUESTING/EVALUATING BIDS
1 - OPERATIONAL	6 - PLANNED-CONSIDERING SO2 CONTROLS
2 - CONSTRUCTIONAL	7 - TERMINATED
3 - PLANNED-CONTRACT AWARDED	8 - INDEFINITELY SHUT DOWN
4 - PLANNED-LETTER OF INTENT SIGNED	9 - NEVER STARTED-UP

+ FOR COMPLETE INFORMATION ON THE INDICATED FGD SYSTEM REFER TO FIRST PAGE LISTED. THE INSTALLATION APPEARS IN OTHER SUMMARY SECTIONS ON THE PAGES IN PARENTHESES. A ZERO INDICATES THAT INFORMATION IS NOT AVAILABLE FOR AN INSTALLATION IN A PARTICULAR SECTION SEARCHED BY THE COMPUTER SYSTEM. SECTION 14 PROVIDES PROCESS DIAGRAMS FOR SEVERAL INSTALLATIONS: A LISTING OF FIGURES IS GIVEN IN SECTION 14.

SECTION 2 (CONTINUED)

STATUS OF INDUSTRIAL BOILERS WITH FGD SYSTEMS

INSTALLATION NAME	LOCATION	START-UP DATE	STATUS*	PAGE NUMBER+
GENERAL MOTORS CORPORATION	TONOWANDA, NEW YORK	6-75	1	67(10,17,20,24,139)
GEORGIA-PACIFIC PAPER CO.	CROSSETT, ARKANSAS	0-75	1	69(10,16,20,25,139)
GETTY OIL COMPANY	BAKERSFIELD, CALIFORNIA	6-77	1	71(10,17,20,25,139)
GETTY OIL COMPANY	BAKERSFIELD, CALIFORNIA	12-78	2	111(10,18,22,26,140)
GREAT SOUTHERN PAPER CO.	CEDAR SPRINGS, GEORGIA	0-75	1	74(10,16,20,26,140)
GREAT WESTERN SUGAR	BILLINGS, MONTANA	10-77	1	76(10,17,20,26,140)
GREAT WESTERN SUGAR	FINDLAY, OHIO	10-74	1	77(10,17,20,25,140)
GREAT WESTERN SUGAR	FORT MORGAN, COLORADO	10-76	1	78(11,17,20,26,141)
GREAT WESTERN SUGAR	FREEMONT, OHIO	10-78	2	112(11,17,22,25,141)
GREAT WESTERN SUGAR	GERING, NEBRASKA	10-75	1	79(11,17,20,26,141)
GREAT WESTERN SUGAR	GREELEY, COLORADO	10-75	1	80(11,17,20,26,141)
GREAT WESTERN SUGAR	LONGMONT, COLORADO	10-73	7	130(11,17, 0,26,141)
GREAT WESTERN SUGAR	LOVELAND, COLORADO	10-73	1	81(11,17,21,26,142)
GREAT WESTERN SUGAR	SCOTTS BLUFF, NEBRASKA	10-75	1	82(11,17,21,26,142)
GRISSOM AIR FORCE BASE	BUNKER HILL, INDIANA	9-79	5	125(12,18,23,24)
HARRIS MINING CO.	SPRUCE PINE, NORTH CAROLINA	0-73	8	131(12,16, 0,27,142)
ITT RAYONIER, INC.	FERNANDINA BEACH, FLORIDA	0-75	1	83(12,16,21,26,142)
KERR-MCGEE CHEMICAL CORP.	TRONA, CALIFORNIA	6-78	1	85(12,16,21,25,142)
MEAD PAPERBOARD CO.	STEVENSON, ALABAMA	0-75	1	87(12,16,21,24,143)
MINN-DAK FARMER'S COOPERATIVE	WAHPETON, NORTH DAKOTA	6-77	1	89(12,18,21,27,143)
MOBIL OIL COMPANY	BUTTONWILLOW, CALIFORNIA	9-78	2	113(12,17,22,25,143)
MOBIL OIL CORPORATION	SAN ARDO, CALIFORNIA	0-74	1	91(13,18,21,25,143)
NEKOOSA PAPERS, INC.	ASHDOWN, ARKANSAS	2-76	1	93(13,16,21,24,144)
PHILLIP MORRIS, INC.	CHESTER, VA.	1-79	2	114(13,16,22, 0,144)
QUALITY MILLS, INC.	MT. AIRY, NORTH CAROLINA	5-70	7	132(13,16, 0,26,144)
RICKENBACKER AIR FORCE BASE	COLUMBUS, OHIO	3-76	1	95(13,18,21,25,144)
SHELL OIL COMPANY	BAKERSFIELD, CALIFORNIA	0- 0	6	127(13,18,23,27)
SHELL OIL COMPANY	TAFT, CALIFORNIA	0- 0	6	128(13,18,23,27)

* STATUS CODES

- 0 - STATUS NOT DEFINED
- 1 - OPERATIONAL
- 2 - CONSTRUCTIONAL
- 3 - PLANNED-CONTRACT AWARDED
- 4 - PLANNED-LETTER OF INTENT SIGNED
- 5 - PLANNED-REQUESTING/EVALUATING BIDS
- 6 - PLANNED-CONSIDERING SO2 CONTROLS
- 7 - TERMINATED
- 8 - INDEFINITELY SHUT DOWN
- 9 - NEVER STARTED-UP

+ FOR COMPLETE INFORMATION ON THE INDICATED FGD SYSTEM REFER TO FIRST PAGE LISTED. THE INSTALLATION APPEARS IN OTHER SUMMARY SECTIONS ON THE PAGES IN PARENTHESES. A ZERO INDICATES THAT INFORMATION IS NOT AVAILABLE FOR AN INSTALLATION IN A PARTICULAR SECTION SEARCHED BY THE COMPUTER SYSTEM. SECTION 14 PROVIDES PROCESS DIAGRAMS FOR SEVERAL INSTALLATIONS; A LISTING OF FIGURES IS GIVEN IN SECTION 14.

SECTION 2 (CONTINUED)

STATUS OF INDUSTRIAL BOILERS WITH FGD SYSTEMS

INSTALLATION NAME	LOCATION	START-UP DATE	STATUS*	PAGE NUMBER+
SHELLER GLOBE CORP.	NORFOLK, VIRGINIA	0-75	1	98(14,18,21,27,145)
ST. JOE ZINC CO.	MONACA, PENNSYLVANIA	12-78	2	115(14,16,22,25,145)
ST. REGIS PAPER CO.	CANTONMENT, FLORIDA	0-73	1	100(14,16,21,27,145)
TEXACO INCORPORATED	SAN ARDO, CALIFORNIA	11-73	1	102(14,16,21,27,145)
TEXACO INCORPORATED	SAN ARDO, CALIFORNIA	3-79	2	116(14,16,22,27,145)
TEXASGULF	GRANGER, WYOMING	9-76	1	104(14,18,21,27,146)
TRANSCO TEXTILES, INC.	AUGUSTA, GEORGIA	3-75	8	133(14,17, 0,26,146)
U.S. GYPSUM CORP.	OAKMONT, PENNSYLVANIA	0- 0	9	134(15,16, 0,24,146)

* STATUS CODES
- 0 - STATUS NOT DEFINED
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- 4 - PLANNED-LETTER OF INTENT SIGNED
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SECTION 3

SUMMARY OF FGD SYSTEMS ON INDUSTRIAL BOILERS

COMPANY INFORMATION	SUMMARY OF RECENT OPERATIONS
ALYESKA PIPELINE SERVICE CO. VALDEZ, ALASKA FMC ENVIRONMENTAL EQUIPMENT OIL (0.03% - 0.1% SULFUR) 50,000 SCFM (DESIGN MAXIMUM) START-UP 6/77 SODIUM HYDROXIDE SCRUBBING STATUS - OPERATIONAL	THE ALYESKA FGD SYSTEM IS UNIQUE IN THAT IT WAS NOT INSTALLED PRIMARILY FOR CONTROL OF EMISSIONS, BUT TO TREAT GAS USED IN THE OIL STORAGE TANKS. FGD OPERATIONS FOR THIS REPORT PERIOD WERE PROBLEM-FREE. CYCLOHEXAMINE IS NOW BEING USED INSTEAD OF HYDRAZINE. PH IS NOW 6 - 7 AND THE MILD DUCTWORK CORROSION SEEMS TO BE UNDER CONTROL. ADDITIONAL CYCLOHEXAMINE SPRAY POINTS MAY BE INSTALLED IF FURTHER PH CONTROL IS REQUIRED.
AMERICAN THREAD CO. MARION, NORTH CAROLINA W.W. SLY MANUFACTURING CO. COAL (1 - 1.5% SULFUR) 18,500 SCFM (TOTAL - 2 BOILERS) START-UP 0/73 CAUSTIC WASTE STREAM STATUS - OPERATIONAL	AMERICAN THREAD IN MARION, NORTH CAROLINA USES A CAUSTIC SCRUBBING APPROACH TO CONTROL PARTICULATE AND SO2 EMISSIONS FROM TWO COAL-FIRED BOILERS. THE PLANT REPORTS THAT CORROSION OF PRESSURE GAUGES AND COPPER LINES IS A PROBLEM AREA. PLANS ARE BEING MADE TO REMOVE THE SCRUBBER I.D. FAN AND UPGRADE THE BOILER I.D. FAN. A PUMP LINING REPLACEMENT CAUSED 3 DAYS DOWNTIME.
ARCO/POLYMERS, INC. MONACA, PENNSYLVANIA FMC ENVIRONMENTAL EQUIPMENT COAL (3.0% SULFUR) 236,000 SCFM (TOTAL - 3 BOILERS) START-UP 6/80 DOUBLE ALKALI (CONCENTRATED) STATUS - PLANNED-CONTRACT AWARDED	ARCO/POLYMERS HAS AWARDED A CONTRACT TO FMC ENVIRONMENTAL EQUIPMENT DIVISION FOR A DOUBLE ALKALI FGD SYSTEM. THE SYSTEM WILL CONSIST OF A SEPARATE SCRUBBER TRAIN FOR EACH OF THE THREE IDENTICAL BOILERS. EACH ABSORBER MODULE WILL HAVE FOUR DISC-AND-DONUT TRAYS AND BE FOLLOWED BY A CHEVRON MIST ELIMINATOR. THE TOTAL INSTALLED CAPITAL COST IS $8,000,000.
ARMCO STEEL MIDDLETOWN, OHIO KOCH ENGINEERING COAL (0.8% SULFUR) 84,000 SCFM (TOTAL - 2 BOILERS) START-UP 0/75 LIME SCRUBBING STATUS - OPERATIONAL	THIS CONTROL SYSTEM SERVES TWO MULTI-RETORT UNDERFEED STOKER, COAL-FIRED BOILERS EACH WITH A CAPACITY OF 100,000 LBS/HR STEAM. ABRASION IS A PROBLEM. PLANS CALL FOR INSTALLATION OF RUBBER PIPE LINING FABRICATED ON SITE. FIBERGLASS PIPING IS ON ORDER. EXCESS AIR HAS BEEN REDUCED TO ABOUT 40% BY PATCHING LEAKS AND REDUCING COMBUSTION AIR.
BELRIDGE OIL CO. MCKITTRICK, CALIFORNIA C-E NATCO CRUDE OIL (1.1% SULFUR) 12,000 SCFM START-UP 11/78 SODIUM HYDROXIDE SCRUBBING STATUS - CONSTRUCTION	BELRIDGE IS SCHEDULED TO START-UP A C-E NATCO FGD SYSTEM IN NOVEMBER 1978. THIS CONTROL SYSTEM WILL BE OPERATING ON A SMALL OIL-FIRED (1.1% SULFUR) STEAM GENERATOR. CONSTRUCTION IS NEARING COMPLETION.
BELRIDGE OIL CO. MCKITTRICK, CALIFORNIA THERMOTICS INC. CRUDE OIL (1.1% SULFUR) 12,000 SCFM START-UP 7/78 SODIUM HYDROXIDE SCRUBBING STATUS - OPERATIONAL	BELRIDGE IS UTILIZING A THERMOTICS, INC. FGD SYSTEM TO CONTROL SO2 EMISSIONS FROM A SMALL OIL-FIRED (1.1% SULFUR) STEAM GENERATOR AT THE MCKITTRICK ENHANCED OIL RECOVERY SITE. START-UP OCCURRED IN JULY 1978.
BELRIDGE OIL COMPANY MCKITTRICK, CALIFORNIA HEATER TECHNOLOGY OIL (1.1% SULFUR) 12,000 SCFM (1 BOILER) START-UP 6/78 SODIUM HYDROXIDE SCRUBBING STATUS - OPERATIONAL	BELRIDGE IS UTILIZING A HEATER TECHNOLOGY FGD SYSTEM TO CONTROL SO2 EMISSIONS FROM A SMALL OIL-FIRED (1.1% SULFUR) STEAM GENERATOR AT AN ENHANCED OIL RECOVERY SITE. START-UP OCCURRED IN JUNE 1978.

SECTION 3 (CONTINUED)

SUMMARY OF FGD SYSTEMS ON INDUSTRIAL BOILERS

COMPANY INFORMATION	SUMMARY OF RECENT OPERATIONS
BUNGE, INC. CAIRO, ILLINOIS DRAVO CORP./NAT'L LIME ASS'N COAL (3% SULFUR) 44,000 SCFM (TOTAL - 2 BOILERS) START-UP 9/77 LIME SCRUBBING STATUS - INDEFFINITELY SHUT DOWN	BUNGE PURCHASED THIS LIME FGD SYSTEM FOR TESTING PURPOSES. THE PLANT REPORTS THAT THE LEWIS SCRUBBER, A HORIZONTAL ROTARY SCRUBBER WITH INTERNAL CHAINS, PERFORMED WELL DURING THE TEST, EFFECTING 94% SO2 CONTROL. BUNGE IS CURRENTLY FIRING LOW SULFUR (0.9%) COAL AND HAS NO PLANS TO REUSE THE SYSTEM.
C.A.M.(CARBIDE-AMOCO-MONSANTO) HOUSTON, TEXAS VENDOR NOT SELECTED FUEL NOT SELECTED 1,200,000 SCFM (1 BOILER) START-UP 10/83 PROCESS NOT SELECTED STATUS - PLANNED-CONSIDERING SO2 CONTROL	UNION CARBIDE, AMOCO, AND MONSANTO HAVE ENTERED INTO A JOINT VENTURE (C.A.M.) WHICH WILL PRODUCE A 600-MW (EQUIVALENT) COGENERATION FACILITY. THE PLANNED BOILER WILL PRODUCE ELECTRIC POWER AND STEAM FOR PROCESS REQUIREMENTS FOR THE 3 PLANTS. START-UP FOR THE POWER GENERATION FACILITY IS SCHEDULED FOR LATE 1983.
CANTON TEXTILES CANTON, GEORGIA FMC ENVIRONMENTAL EQUIPMENT COAL (0.8% SULFUR) 25,000 SCFM (1 BOILER) START-UP 6/74 CAUSTIC WASTE STREAM STATUS - OPERATIONAL	AT CANTON TEXTILES THE CONTROL SYSTEM CONSISTS OF AN FMC MEDIUM ENERGY VENTURI SCRUBBER AND UTILIZES A CAUSTIC WASTE STREAM FOR SO2 REMOVAL. THE UNIT HAS BEEN IN OPERATION SINCE JUNE 1974. CANTON AGAIN REPORTED NO OPERATIONAL PROBLEMS DURING THIS REPORT PERIOD. GAS FIRING WAS RESTARTED IN MID-MAY 1977, SO THE SCRUBBER WILL NOT OPERATE UNTIL COAL USE RESUMES IN OCT. THE PLANT REPORTS AN OPERABILITY OF 100% DURING COAL FIRING OPERATIONS.
CARBORUNDUM ABRASIVES BUFFALO, NEW YORK CARBORUNDUM ENVIR. SYS. LTD. COAL (2.2% SULFUR) 30,000 SCFM (TOTAL - 2 BOILERS) START-UP 0/ 0 LIME SCRUBBING STATUS - PLANNED-CONTRACT AWARDED	NO DEFINITE PLANS HAVE BEEN MADE FOR THE CONTROL OF SO2 EMISSIONS FROM THIS BOILER. THE FUTURE OF THE CONTROL SYSTEM WILL BE DETERMINED BY A REGULATORY AGENCY DECISION EXPECTED NEAR THE END OF 1978. THE CURRENTLY OPERATING VENTURI (L/G = 10) CONTROLS ONLY PARTICULATE, BUT TIE-INS HAVE BEEN PROVIDED FOR A LIME SCRUBBING SYSTEM USING A 6-STAGE SPRAY TOWER FOR SO2 CONTROL.
CATERPILLAR TRACTOR CO. EAST PEORIA, ILLINOIS FMC ENVIRONMENTAL EQUIPMENT COAL (3.2% SULFUR) 210,000 SCFM (TOTAL - 4 BOILERS) START-UP 4/78 DOUBLE ALKALI (CONCENTRATED) STATUS - OPERATIONAL	START-UP OCCURRED IN APRIL 1978. FGD OPERATIONS PROCEEDED FOR 30 DAYS BEFORE BOILER PLANT SHUTDOWN FOR THE SUMMER. THE 4 FMC CONCENTRATED DOUBLE ALKALI SYSTEMS WERE STILL IN A START-UP MODE WHEN SHUTDOWN OCCURRED. THE PLANT CONDUCTED NO PERFORMANCE TESTS. THE SYSTEMS ARE DESIGNED TO REMOVE 90% OF THE INLET SO2 WHILE THE BOILERS ARE BURNING HIGH-SULFUR ILLINOIS COAL. THE FGD SYSTEM HAS JUST STARTED UP AFTER SUMMER SHUTDOWN.
CATERPILLAR TRACTOR CO. JOLIET, ILLINOIS ZURN INDUSTRIES COAL (3.2% SULFUR) 67,000 SCFM (TOTAL - 2 BOILERS) START-UP 9/74 DOUBLE ALKALI (DILUTE) STATUS - OPERATIONAL	THE FGD SYSTEM CONSISTS OF AN INDEPENDENT SCRUBBING TRAIN ON EACH OF TWO COAL-FIRED BOILERS. THESE BOILERS HAVE BEEN OPERATIONAL EACH HEATING SEASON SINCE OCTOBER 1974. SINCE THAT DATE, SCRUBBER AVAILABILITY HAS BEEN AVERAGING 80-85%. SO2 MONITORING PROBES OF 304 SS, 316L SS, AND TEFLON COATING WERE TRIED WITHOUT SUCCESS. HASTELLOY C PROBES ARE NOW BEING EVALUATED.
CATERPILLAR TRACTOR CO. MAPLETON, ILLINOIS FMC ENVIRONMENTAL EQUIPMENT COAL (3.2% SULFUR) 157,000 SCFM (TOTAL - 3 BOILERS) START-UP 10/78 DOUBLE ALKALI (CONCENTRATED) STATUS - CONSTRUCTION	AT THE CATERPILLAR MAPLETON PLANT, FMC CONCENTRATED MODE DUAL ALKALI TECHNOLOGY WILL BE UTILIZED TO CONTROL SO2 EMISSIONS. THREE SCRUBBER SYSTEMS WILL START-UP IN OCT. 1978, CONTROLLING EMISSIONS FROM THREE COAL-FIRED BOILERS. CONSTRUCTION IS NEARING COMPLETION. SPECIAL MODIFICATIONS ARE DELAYING OPERATION.

SECTION 3 (CONTINUED)

SUMMARY OF FGD SYSTEMS ON INDUSTRIAL BOILERS

COMPANY INFORMATION	SUMMARY OF RECENT OPERATIONS
CATERPILLAR TRACTOR CO. MAPLETON, ILLINOIS FMC ENVIRONMENTAL EQUIPMENT COAL (3.2% SULFUR) 262,000 SCFM (TOTAL - 5 BOILERS) START-UP 10/79 DOUBLE ALKALI (CONCENTRATED) STATUS - CONSTRUCTION	AT THE MAPLETON PLANT, AN ADDITIONAL 5 NEW BOILERS ARE SLATED TO BE EQUIPPED WITH FMC DOUBLE ALKALI FGD SYSTEMS. TWO OF THESE ARE SLATED TO BEGIN SO2 CONTROL OPERATIONS IN THE 1978 - 1979 HEAT SEASON. AS OF NOW, THERE IS NO FIRM START-UP SCHEDULED FOR THE OTHER 3 SYSTEMS.
CATERPILLAR TRACTOR CO. MORTON, ILLINOIS ZURN INDUSTRIES COAL (3.2% SULFUR) 40,000 SCFM (TOTAL -2 BOILERS) START-UP 1/78 DOUBLE ALKALI (DILUTE) STATUS - OPERATIONAL	THE CATERPILLAR MORTON PLANT UTILIZES ZURN INDUSTRIES' DILUTE MODE DOUBLE ALKALI TECHNOLOGY TO CONTROL EMISSIONS FROM THE STEAM PLANT. FGD SYSTEM START-UP OCCURRED AT THE BEGINNING OF 1978. ACCEPTANCE TESTING HAS BEEN DELAYED DUE TO A PUFFING PROBLEM BUT WILL BE ATTEMPTED LATE THIS FALL.
CATERPILLAR TRACTOR CO. MOSSVILLE, ILLINOIS FMC ENVIRONMENTAL EQUIPMENT COAL (3.2% SULFUR) 140,000 SCFM (TOTAL - 4 BOILERS) START-UP 10/75 DOUBLE ALKALI (CONCENTRATED) STATUS - OPERATIONAL	THE CATERPILLAR MOSSVILLE PLANT HAS UTILIZED AN FMC CONCENTRATED MODE FGD SYSTEM EACH HEATING SEASON SINCE OCTOBER 1975. THERE ARE FOUR COAL-FIRED BOILERS EACH BEING TREATED BY A SEPARATE SCRUBBING TRAIN. PROBLEMS WITH THE VENTURI SPRAY NOZZLES HAVE BEEN ENCOUNTERED. 316L SS NOZZLES ARE BEING USED AT THIS TIME. THE VENTURI AUTOMATIC CONTROL HAS NOT YET BEEN DEBUGGED. THE SLUDGE HANDLING SYSTEM IS BEING REEVALUATED DUE TO MANY PROBLEMS. GUILLOTINE DAMPERS EXPERIENCING SAME PROBLEM AS AT JOLIET PLANT. WEAR PLATES AT SCRUBBER ARE WORKING WELL.
CHANSLOR WESTERN OIL & DEV. CO BAKERSFIELD, CALIFORNIA FMC ENVIRONMENTAL EQUIPMENT OIL (1.5% SULFUR) 70,000 SCFM (TOTAL - 8 BOILERS) START-UP 12/78 DOUBLE ALKALI (CONCENTRATED) STATUS - CONSTRUCTION	CHANSLOR WESTERN HAS PURCHASED A DOUBLE ALKALI FGD SYSTEM FROM FMC. CONSTRUCTION IS NEARING COMPLETION AND START-UP IS SCHEDULED FOR DECEMBER 1978. FLUE GAS FROM 8 SMALL OIL-FIRED (1.5% SULFUR) STEAM GENERATORS WILL BE MANIFOLDED INTO ONE FGD SYSTEM.
CHEVRON U.S.A. INC. BAKERSFIELD, CALIFORNIA KOCH ENGINEERING OIL (1.1% SULFUR) 248,000 SCFM (TOTAL - 18 BOILERS) START-UP 7/78 SODIUM CARBONATE SCRUBBING STATUS - OPERATIONAL	CHEVRON U.S.A. HAS PURCHASED THREE FGD SYSTEMS FROM KOCH ENGINEERING. THE SODIUM CARBONATE SCRUBBING SYSTEMS WENT ON-STREAM IN JUNE/JULY 1978. THE STARTUP HAS BEEN SUCCESSFUL. THE SYSTEMS ARE DESIGNED TO REDUCE SO2 EMISSIONS BELOW 70 PPM. ONLY TWO OF THE THREE FGD SYSTEMS ARE OPERATING DUE TO LOW STEAM DEMAND. NO MAJOR PROBLEMS HAVE OCCURRED. OPERABILITY WAS 95%.
CHEVRON U.S.A. INC. BAKERSFIELD, CALIFORNIA KOCH ENGINEERING OIL (1.1% SULFUR) 146,000 SCFM (TOTAL - 12 BOILERS) START-UP 4/79 SODIUM CARBONATE SCRUBBING STATUS - PLANNED-REQUESTING/EVALUATING BIDS	CHEVRON U.S.A. IS PLANNING TO INSTALL TWO MORE FGD SYSTEMS AT BAKERSFIELD OIL SITE. THESE WILL BE ONCE-THROUGH, SODIUM CARBONATE SCRUBBING SYSTEMS AND ARE SCHEDULED TO GO ON-STREAM BY APRIL 1979. A CONTRACT HAS BEEN AWARDED TO KOCH ENGINEERING FOR THE DESIGN AND INSTALLATION OF THE 2 SYSTEMS. CONSTRUCTION IS SCHEDULED TO BEGIN IN JANUARY.
DUPONT, INC. GEORGIA VENDOR NOT SELECTED COAL (1.5% SULFUR) 280,000 SCFM (TOTAL - 3 BOILERS) START-UP 0/87 DOUBLE ALKALI STATUS - PLANNED-CONSIDERING SO2 CONTROL	DUPONT HAS ANNOUNCED PLANS TO ERECT A COAL-FIRED BOILER AT AN AS YET UNSPECIFIED SITE IN GEORGIA. THE COMPANY HAS DECIDED UPON A DOUBLE ALKALI FGD STRATEGY TO CONTROL SO2 EMISSIONS FROM 3 COAL-FIRED BOILERS. START-UP IS SLATED FOR 1987.

SECTION 3 (CONTINUED)

SUMMARY OF FGD SYSTEMS ON INDUSTRIAL BOILERS

COMPANY INFORMATION	SUMMARY OF RECENT OPERATIONS
DUPONT, INC. TEXAS VENDOR NOT SELECTED COAL (0.5% SULFUR) 320,000 SCFM (TOTAL - 2 BOILERS) START-UP 0/82 LIMESTONE SCRUBBING STATUS - PLANNED-CONSIDERING SO2 CONTROL	DUPONT HAS ANNOUNCED PLANS TO ERECT A COAL-FIRED BOILER AT AN AS YET UNSPECIFIED SITE IN TEXAS. THE COMPANY HAS DECIDED UPON A LIMESTONE FGD STRATEGY TO CONTROL SO2 EMISSIONS FROM 2 COAL-FIRED BOILERS. START-UP IS SLATED FOR 1982.
FIRESTONE TIRE AND RUBBER CO. POTTSTOWN, PENNSYLVANIA FMC ENVIRONMENTAL EQUIPMENT COAL (2.5 - 3.0% SULFUR) 8070 SCFM (13,000 ACFM @ 300 F) START-UP 1/75 DOUBLE ALKALI (CONCENTRATED) STATUS - OPERATIONAL	THE FGD SYSTEM AT FIRESTONE-POTTSTOWN CONSISTS OF AN FMC DOUBLE ALKALI DUAL THROAT VENTURI SCRUBBER. THIS SO2 CONTROL SYSTEM WAS BUILT AS A DEMONSTRATION PROJECT FUNDED BY FIRESTONE. THE SYSTEM OPERATED WITH AN AVAILABILITY VALUE OF 91% IN THE FALL QUARTER OF 1977. THE MAJOR PROBLEM AREA WAS EROSION OF FAN AND SPRAY NOZZLES BY FLYASH. THE FAN AND SPRAY RODS WERE REPLACED IN APRIL 1978.
FMC (SODA ASH PLANT) GREEN RIVER, WYOMING FMC ENVIRONMENTAL EQUIPMENT COAL (1% SULFUR) 446,000 SCFM (TOTAL - 2 BOILERS) START-UP 5/76 SODIUM CARBONATE SCRUBBING STATUS - OPERATIONAL	THE FGD SYSTEM CONSISTS OF TWO FMC SODIUM SCRUBBING UNITS TO REMOVE SULFUR DIOXIDE AND PARTICULATE MATTER FROM THE FLUE GAS OF TWO BOILERS. SCRUBBER CORROSION HAS BEEN A PROBLEM. PLANT PERSONNEL FELT THAT THE CEILCOTE LINING WAS IMPROPERLY APPLIED. THE DAMPERS EXPERIENCE PROBLEMS IN OPERATION DURING COLD WEATHER. A PUMP SHAFT HAD TO BE REPLACED DURING 2ND QUARTER 1978. MAINTENANCE WAS PERFORMED ON THE FGD SYSTEM DURING THIS PERIOD.
GENERAL MOTORS CORPORATION DAYTON, OHIO ENTOLETER, INC. COAL(0.7% - 2.0% SULFUR) 36,000 SCFM (TOTAL - 2 BOILERS) START-UP 9/74 SODIUM HYDROXIDE SCRUBBING STATUS - OPERATIONAL	THE FGD SYSTEM CONSISTS OF TWO ENTOLETER SODIUM HYDROXIDE SCRUBBING UNITS. THE AVERAGE OPERABILITY OF THE SYSTEM IS 95%. THE ORIGINAL 316L SS MIST ELIMINATORS ARE SEVERELY CORRODED, AND WILL BE REPLACED BY HASTELLOY-G. CONSTRUCTION IS SCHEDULED TO BEGIN ON DESIGN MODIFICATIONS ABOUT THE END OF OCTOBER. THE SCRUBBER LINING IS FLAKING OFF, BUT THIS IS DUE TO IMPROPER APPLICATION. THE PH MONITORING SYSTEM NOW IN USE CONTINUALLY SEEMS TO BE OUT OF CALIBRATION AND IS BEING REDESIGNED. BEING REDESIGNED.
GENERAL MOTORS CORPORATION PARMA, OHIO GM ENVIRONMENTAL COAL (2.5% SULFUR) 128,400 SCFM (TOTAL - 4 BOILERS) START-UP 3/74 DOUBLE ALKALI (DILUTE) STATUS - OPERATIONAL	THE FGD SYSTEM CONSISTS OF 4 GM-DESIGNED DOUBLE ALKALI SCRUBBERS OPERATING ON 4 BOILERS. THE SCRUBBERS HANDLE A TOTAL 240,000 ACFM OF FLUE GAS. THE SCRUBBERS HAVE BEEN OPERATIONAL SINCE MARCH 1974. WARREN-RUPP DIAPHRAGM PUMPS REPLACED EXISTING LINE SLURRY FEED PUMPS. A RELIABILITY OF 100% WAS REPORTED FOR THIS PERIOD.
GENERAL MOTORS CORPORATION PONTIAC, MICHIGAN PEABODY ENGINEERING COAL (0.84% SULFUR) 107,300 SCFM (TOTAL - 2 BOILERS) START-UP 4/76 SODIUM HYDROXIDE SCRUBBING STATUS - OPERATIONAL	THE SCRUBBER SYSTEM CONSISTS OF TWO G.M. SODIUM UNITS FOR THE REMOVAL OF FLYASH AND SULFUR DIOXIDE FROM THE FLUE GAS OF TWO COAL-FIRED BOILERS. PLANT HAS BEEN EXPERIENCING FLYASH ABRASION IN PUMPS AND PIPING. PRESSURE FILTERS WILL BE INSTALLED IN THE SCRUBBER EFFLUENT LINES.
GENERAL MOTORS CORPORATION ST. LOUIS, MISSOURI A.D. LITTLE COAL (3.2% SULFUR) 64,000 SCFM (TOTAL - 2 BOILERS) START-UP 0/72 SODIUM HYDROXIDE SCRUBBING STATUS - OPERATIONAL	THIS SO2 CONTROL SYSTEM CONSISTS OF TWO GM DESIGNED SODIUM SCRUBBING UNITS OPERABLE ON TWO OF FOUR COAL-FIRED BOILERS. DURING THIS REPORT PERIOD, STACK CORROSION HAS BEEN THE MAIN PROBLEM. PLANS ARE BEING MADE TO REDESIGN DUCTWORK DOWNSTREAM OF THE SCRUBBER. THE SYSTEM IS PROVIDED WITH 60 F REHEAT AND HAS THE CAPABILITY FOR FGD SYSTEM BYPASS.

SECTION 3 (CONTINUED)

SUMMARY OF FGD SYSTEMS ON INDUSTRIAL BOILERS

COMPANY INFORMATION	SUMMARY OF RECENT OPERATIONS
GENERAL MOTORS CORPORATION TONOWANDA, NEW YORK FMC ENVIRONMENTAL EQUIPMENT COAL (1.2% SULFUR) 92,000 SCFM (TOTAL - 4 BOILERS) START-UP 6/75 SODIUM HYDROXIDE SCRUBBING STATUS - OPERATIONAL	THE FGD SYSTEM CONSISTS OF FOUR GM SODIUM SCRUBBING UNITS FOR THE REMOVAL OF PARTICULATES AND SULFUR DIOXIDE FROM FOUR COAL-FIRED BOILERS. THE SCRUBBERS ARE EQUIPPED WITH VENTURI SCRUBBERS FOR PARTICULATE REMOVAL. UNSTABLE PH CONTROL, PIPE EROSION AND STACK CORROSION HAVE BEEN THE MAIN PROBLEM AREAS. TO CORRECT THESE PROBLEMS, THE SOLUTIONS HAVE BEEN, RESPECTIVELY, REPLACEMENT OF CONTROL SENSORS, PIPING AND RELINING OF THE STACK.
GEORGIA-PACIFIC PAPER CO. CROSSETT, ARKANSAS AIRPOL INDUSTRIES BARK,COAL/OIL (1% - 1.5% SULFUR) 220,000 SCFM (1 BOILER) START-UP 0/75 CAUSTIC WASTE STREAM STATUS - OPERATIONAL	THE FGD SYSTEM CONSISTS OF AN AIRPOL CAUSTIC SCRUBBING UNIT TO REMOVE SULFUR DIOXIDE AND PARTICULATE MATTER FROM THE FLUE GAS OF A COAL/BARK OR OIL/BARK POWER BOILER. THE SYSTEM IS PRECEDED BY CYCLONES FOR PARTICULATE REMOVAL. A RECIRCULATION PUMP WAS REPLACED DUE TO LOSS OF IMPELLER LINING. SCRUBBER WAS DOWN ABOUT 36 HRS. DUE TO PUMP FAILURE.
GETTY OIL COMPANY BAKERSFIELD, CALIFORNIA FMC ENVIRONMENTAL EQUIPMENT COAL (1.1% SULFUR) 72,000 SCFM (TOTAL - 6 BOILERS) START-UP 6/77 SODIUM CARBONATE SCRUBBING STATUS - OPERATIONAL	THE SODIUM CARBONATE SCRUBBING FGD SYSTEM WAS RETROFITTED BY FMC IN JUNE 1977. THE SYSTEM HAS AN SO2 REMOVAL EFFICIENCY OF 90%. NEW 316L SS RECIRCULATION LINES HAVE BEEN INSTALLED. A SILICON DISPERSANT IS BEING EVALUATED. THE SYSTEM EXPERIENCED A 2-DAY OUTAGE TO REPLACE FAN BEARINGS.
GETTY OIL COMPANY BAKERSFIELD, CALIFORNIA PROPRIETARY DESIGN OIL (1.1% SULFUR) 993,750 SCFM (TOTAL-72 BOILERS) START-UP 12/78 SODIUM CARBONATE SCRUBBING STATUS - CONSTRUCTION	GETTY OIL COMPANY HAS DESIGNED 9 MORE SODIUM CARBONATE SCRUBBING FGD SYSTEMS IN-HOUSE. EACH SYSTEM, UNLIKE THE OPERATING UNITS, WILL HAVE A SCRUBBER PURCHASED FROM KOCH CONTAINING 3 FLEXITRAYS AND 1 FLEXIMESH DEMISTER. EACH SCRUBBER WILL TREAT GASES FROM 8 BOILERS. CONSTRUCTION IS IN PROGRESS AND STARTUP OF THE FINAL UNIT IS SCHEDULED FOR MID-FEBUARY 1979.
GREAT SOUTHERN PAPER CO. CEDAR SPRINGS, GEORGIA AIRPOL INDUSTRIES BARK,COAL/OIL (1.0% - 2.0% SULFUR) 420,000 SCFM (TOTAL - 2 BOILERS) START-UP 0/75 CAUSTIC WASTE STREAM STATUS - OPERATIONAL	THE FGD SYSTEM CONSISTS OF TWO AIRPOL CAUSTIC SCRUBBERS TO CONTROL PARTICULATE AND SULFUR DIOXIDE FROM TWO POWER BOILERS. THE PRIMARY FUEL IS BARK/COAL (BARK/OIL IS FIRED OCCASIONALLY). THE FOLLOWING PROBLEMS HAVE BEEN ENCOUNTERED; EROSION AND PLUGGAGE OF THE PH PROBES, INTERNAL WEAR ON PUMPS, AND EROSION IN THE RECIRCULATION LINES.
GREAT WESTERN SUGAR BILLINGS, MONTANA GREAT WESTERN SUGAR COAL (0.7% SULFUR) 60,000 SCFM (TOTAL - 3 BOILERS) START-UP 10/77 AMMONIA-LADEN PROCESS WATER STATUS - OPERATIONAL	GREAT WESTERN SUGAR USES CONDENSATE PROCESS WATER PRIMARILY FOR PARTICULATE CONTROL. THE WATER HAS A HIGH PH (8.7) BUT THE SYSTEM HAS A LOW SO2 REMOVAL BECAUSE THE WATER IS INTRODUCED THROUGH PIPES RATHER THAN SPRAY NOZZLES.
GREAT WESTERN SUGAR FINDLAY, OHIO GREAT WESTERN SUGAR COAL (1.2% SULFUR, AVERAGE) 65,230 SCFM (TOTAL - 2 BOILERS) START-UP 10/74 SODIUM CARBONATE SCRUBBING STATUS - OPERATIONAL	THE VENTURI TOWER WAS MAINLY DESIGNED FOR PARTICULATE CONTROL, AND WAS STARTED UP IN OCT.'74. THE PARTICULATE AND SO2 REMOVAL EFFICIENCIES ARE 90% AND 76% RESPECTIVELY. THE SO2 CONTROL IS EFFECTED BY THE PROCESS CONDENSATE USED FOR SCRUBBING (PH=8.7). THE PLANT OPERATES ONLY DURING THE FALL QUARTER.

SECTION 3 (CONTINUED)

SUMMARY OF FGD SYSTEMS ON INDUSTRIAL BOILERS

COMPANY INFORMATION	SUMMARY OF RECENT OPERATIONS
GREAT WESTERN SUGAR FORT MORGAN, COLORADO GREAT WESTERN SUGAR COAL (1.2% SULFUR, AVERAGE) 65,230 SCFM (TOTAL - 2 BOILERS) START-UP 10/76 AMMONIA-LADEN PROCESS WATER STATUS - OPERATIONAL	THE VENTURI SCRUBBER WAS DESIGNED FOR PARTICULATE CONTROL AND STARTED IN OCT'76. THE CONDENSATE PROCESS WATER USED HAS A HIGH PH (8.7) WHICH REMOVES SOME SO2. THE PARTICULATE AND SO2 CONTROL EFFICIENCIES ARE 96% AND 40% RESPECTIVELY.
GREAT WESTERN SUGAR FREEMONT, OHIO GREAT WESTERN SUGAR COAL (3% SULFUR) 40,000 SCFM (TOTAL - 2 BOILERS) START-UP 10/78 SODIUM CARBONATE SCRUBBING STATUS - CONSTRUCTION	PARTICULATE AND SO2 EMISSIONS WILL BE CONTROLLED BY A SCRUBBER/ABSORBER MODULE OF PROPRIETARY DESIGN. THE FLUE GAS IS GENERATED BY TWO UNION BOILERS, EACH RATED @ 70,000 LB/HR STEAM. STARTUP IS SCHEDULED FOR OCTOBER 1978.
GREAT WESTERN SUGAR GERING, NEBRASKA GREAT WESTERN SUGAR COAL (1.2% SULFUR, AVERAGE) 110,000 SCFM (TOTAL - 2 BOILERS) START-UP 10/75 AMMONIA-LADEN PROCESS WATER STATUS - OPERATIONAL	GREAT WESTERN SUGAR USES CONDENSATE PROCESS WATER PRIMARILY FOR PARTICULATE CONTROL. THE WATER HAS A HIGH PH (8.7) BUT THE SYSTEM HAS A LOW SO2 REMOVAL. THE VENTURI SCRUBBERS WERE INSTALLED IN OCT'75. PLANT OPERATES ONLY DURING THE FALL QUARTER.
GREAT WESTERN SUGAR GREELEY, COLORADO GREAT WESTERN SUGAR COAL (0.6% SULFUR) 25,000 SCFM (1 BOILER) START-UP 10/75 AMMONIA-LADEN PROCESS WATER STATUS - OPERATIONAL	GREAT WESTERN SUGAR USES CONDENSATE PROCESS WATER PRIMARILY FOR PARTICULATE CONTROL. THE WATER HAS A HIGH PH (8.7) BUT THE SYSTEM HAS A LOW SO2 REMOVAL BECAUSE THE WATER IS INTRODUCED THROUGH PIPES RATHER THAN SPRAY NOZZLES.
GREAT WESTERN SUGAR LONGMONT, COLORADO GREAT WESTERN SUGAR COAL (0.7% SULFUR) SCFM-N/A START-UP 10/73 AMMONIA-LADEN PROCESS WATER STATUS - TERMINATED	SUGAR PRODUCTION AND ALL PLANT OPERATIONS HAVE BEEN TERMINATED AT THE LONGMONT PLANT.
GREAT WESTERN SUGAR LOVELAND, COLORADO GREAT WESTERN SUGAR COAL (1.2% SULFUR, AVERAGE) 121,000 SCFM (TOTAL - 2 BOILERS) START-UP 10/73 AMMONIA-LADEN PROCESS WATER STATUS - OPERATIONAL	GREAT WESTERN SUGAR USES CONDENSATE PROCESS WATER PRIMARILY FOR PARTICULATE CONTROL. THE WATER HAS A HIGH PH (8.7) BUT THE SYSTEM HAS A LOW SO2 REMOVAL. THE SCRUBBERS WERE INSTALLED IN OCTOBER 1973. PLANT OPERATES ONLY DURING THE FALL QUARTER.
GREAT WESTERN SUGAR SCOTTS BLUFF, NEBRASKA GREAT WESTERN SUGAR COAL (1.2% SULFUR, AVERAGE) 65,230 SCFM (TOTAL - 2 BOILERS) START-UP 10/75 AMMONIA-LADEN PROCESS WATER STATUS - OPERATIONAL	THE PLANT OPERATES ONLY DURING THE FALL QUARTER OF EACH YEAR. THE VENTURI SCRUBBER WAS DESIGNED FOR PARTICULATE CONTROL AND WAS STARTED IN OCT'75. THE PARTICULATE AND SO2 REMOVAL EFFICIENCIES ARE 95% AND 76% RESPECTIVELY. THE SO2 CONTROL IS CAUSED BY THE PROCESS CONDENSATE USED FOR SCRUBBING(PH=8.7).

SECTION 4 (CONTINUED)

SUMMARY OF FGD SYSTEMS ON INDUSTRIAL BOILERS

COMPANY INFORMATION	SUMMARY OF RECENT OPERATIONS
GRISSOM AIR FORCE BASE BUNKER HILL, INDIANA VENDOR NOT SELECTED COAL (0.9% - 4.6% SULFUR) 32,000 SCFM (TOTAL - 3 BOILERS) START-UP 9/79 DOUBLE ALKALI (CONCENTRATED) STATUS - PLANNED-REQUESTING/EVALUATING BIDS	THE AIR FORCE HAS INITIATED A PROJECT WHICH WILL ADD ONE NEW COAL-FIRED BOILER TO THE EXISTING STEAM PLANT. A PORTION OF THE PROJECT INCLUDES AN FGD SYSTEM FOR THE NEW BOILER AND TWO EXISTING UNITS. THE A-E FIRM, FOSDICK AND HILMER, HAS SPECIFIED A CONCENTRATED DOUBLE ALKALI FGD SYSTEM, AND BIDS ARE CURRENTLY BEING EVALUATED. PROJECT COMPLETION IS SCHEDULED FOR AUGUST 30, 1979.
HARRIS MINING CO. SPRUCE PINE, NORTH CAROLINA W.W. SLY MANUFACTURING CO. COAL (0.8% SULFUR) 4,000 SCFM (TOTAL - 2 BOILERS) START-UP 0/73 WATER SCRUBBING (NA,NH3 OPTN.) STATUS - INDEFFINITELY SHUT DOWN	THE FGD SYSTEM CONSISTS OF A W.W. SLY IMPINJET SCRUBBER CURRENTLY BEING USED STRICTLY AS A PARTICULATE CONTROL DEVICE. THE SYSTEM HAS THE CAPABILITY OF SCRUBBING WITH AMMONIA OR CAUSTIC IF SO2 CONTROL IS NECESSARY. HOWEVER, AS LONG AS, CURRENT LOW-SULFUR COAL SUPPLIES LAST, THERE IS NO NEED FOR SO2 CONTROLS.
ITT RAYONIER, INC. FERNANDINA BEACH, FLORIDA AIRPOL INDUSTRIES BARK,OIL (2.0% - 2.5% SULFUR) 201,000 SCFM (TOTAL - 2 BOILERS) START-UP 0/75 SODIUM HYDROXIDE SCRUBBING STATUS - OPERATIONAL	AT FERNANDINA BEACH, ITT RAYONIER FIRES BARK AND OIL IN TWO OF THE FOUR PROCESS STEAM BOILERS. PARTICULATE AND SO2 EMISSIONS ARE CONTROLLED IN TWO AIRPOL SCRUBBING TRAINS. THE PLANT HAS PERMANENTLY CONVERTED FROM WASTE STREAM CAUSTIC SCRUBBING TO A SODIUM HYDROXIDE CONTROL. APPROXIMATE SCRUBBER OPERABILITY SINCE JAN. HAS BEEN 95%. BEARINGS IN THE I.D. FAN HAD TO BE REPLACED. THE SYSTEM WAS DOWN FOR 3 DAYS DUE TO BOILER-RELATED PROBLEMS
KERR-MCGEE CHEMICAL CORP. TRONA, CALIFORNIA COMBUSTION EQUIPMENT ASSOC. COKE/COAL/OIL (0.5% - 5.0% SULFUR) 490,000 SCFM (TOTAL - 2 BOILERS) START-UP 6/78 SODIUM CARBONATE SCRUBBING STATUS - OPERATIONAL	THE FGD SYSTEM CONSISTS OF A COMBUSTION EQUIPMENT (CEA) SODA ASH SCRUBBING SYSTEM WHICH REMOVES FLY-ASH AND SULFUR DIOXIDE FROM THE FLUE GAS OF TWO COAL-FIRED BOILERS. THE SYSTEM WENT ON STREAM IN JUNE. SIEVE TRAYS WERE REPLACED BY 317L SS IN AUGUST AND SEPTEMBER. COAL AND COKE CONSTITUTED 90 - 95% OF THE FUEL. OIL WAS NOT USED.
MEAD PAPERBOARD CO. STEVENSON, ALABAMA AIRPOL INDUSTRIES OIL (1.5% - 3% SULFUR) 100,000 SCFM (TOTAL - 2 BOILERS) START-UP 0/75 SODIUM HYDROXIDE SCRUBBING STATUS - OPERATIONAL	AIRPOL INDUSTRIES HAS SUPPLIED A PARTICULATE AND SO2 CONTROL SYSTEM FOR THE TWO OIL-FIRED BOILERS AT THIS MEAD PULP MILL. DURING A JUNE PULP MILL SHUTDOWN, THE RUBBER LINER IN THE ABSORBER WAS REPAIRED. ALSO, MODIFICATIONS WERE IMPLEMENTED AT THE ABSORBER MODULE INLET WITH THE INTENT OF PREVENTING FLY ASH EROSION IN THE MODULE. FGD SYSTEM OPERABILITY WAS REPORTED TO BE 100%.
MINN-DAK FARMER'S COOPERATIVE WAHPETON, NORTH DAKOTA KOCH ENGINEERING LIGNITE (1.0% SULFUR) 160,000 SCFM (TOTAL - 2 BOILERS) START-UP 6/77 AMMONIA SCRUBBING STATUS - OPERATIONAL	KOCH ENGINEERING HAS SUPPLIED TWO AMMONIA-BASED SO2 CONTROL SYSTEMS FOR THESE COAL-FIRED BOILERS. EACH YEAR THE PLANT ONLY PRODUCES SUGAR DURING THE SEPT. - FEB. PERIOD. THE SYSTEM WAS STARTED ON SEPTEMBER 12 AND DID NOT OPERATE DURING THIS REPORT PERIOD. START-UP PROCEEDED SMOOTHLY. THE PLANT HAS MADE SOME FGD PROCESS MODIFICATIONS DURING THE SCHEDULED SHUTDOWN.
MOBIL OIL COMPANY BUTTONWILLOW, CALIFORNIA HEATER TECHNOLOGY OIL (1.1% SULFUR) 42,000 SCFM (TOTAL - 7 BOILERS) START-UP 9/78 SODIUM CARBONATE SCRUBBING STATUS - CONSTRUCTION	MOBIL OIL HAS PURCHASED SEVEN EDUCTOR SCRUBBERS FROM HEATER TECHNOLOGY FOR THE CONTROL OF EMISSIONS FROM 7 STEAM GENERATORS(25 MM BTU/HR). EACH SYSTEM CONSISTS OF A VENTURI SECTION, A RECYCLE TANK, AND AN OUTLET DUCT WITH A MIST ELIMINATOR. START-UP IS SCHEDULED FOR SEPT. 1978.

SECTION 3 (CONTINUED)

SUMMARY OF FGD SYSTEMS ON INDUSTRIAL BOILERS

COMPANY INFORMATION	SUMMARY OF RECENT OPERATIONS
MOBIL OIL CORPORATION SAN ARDO, CALIFORNIA MOBIL OIL COMPANY OIL (2.0% - 2.25% SULFUR) 182,000 SCFM (TOTAL - 30 BOILERS) START-UP 0/74 SODIUM HYDROXIDE SCRUBBING STATUS - OPERATIONAL	MOBIL HAS DESIGNED THE FGD SYSTEM BY IN-HOUSE ENGINEERING BASED ON A PATENTED SODIUM HYDROXIDE SCRUBBING PROCESS. CORROSION OF MIST ELIMINATOR AND I.D. FAN BLADES HAVE BEEN THE MAJOR PROBLEM AREAS. THE SO2 REMOVAL EFFICIENCY IS CHANGED BY ADJUSTING THE PH OF INLET LIQUOR. FGD SYSTEM RELIABILITY WAS ESTIMATED TO BE 90%.
NEKOOSA PAPERS, INC. ASHDOWN, ARKANSAS AIRPOL INDUSTRIES COAL (1% - 1.5% SULFUR) 211,000 SCFM (TOTAL - 1 BOILER) START-UP 2/76 CAUSTIC SCRUBBING STATUS - OPERATIONAL	THE FGD SYSTEM CONSISTS OF TWO AIR-POL CAUSTIC SCRUBBERS CONTROLLING FLYASH AND SULFUR DIOXIDE. THE ONLY PROBLEM REPORTED DURING THIS PERIOD WAS A RECYCLE PUMP BEARING FAILURE. HOWEVER ALL FLUE GAS WAS TREATED BY THE OTHER SCRUBBER WHILE THE BEARING WAS REPLACED.
PHILLIP MORRIS, INC. CHESTER, VA. FLAKT, INC. COAL (1.7% SULFUR) 39,000 SCFM (TOTAL - 1 BOILER) START-UP 1/79 SODIUM CARBONATE SCRUBBING STATUS - CONSTRUCTION	CONSTRUCTION IS NEARING COMPLETION ON A NON-REGENERABLE SODIUM CARBONATE FGD SYSTEM SUPPLIED BY FLAKT, INC. THE SYSTEM WILL CONTROL EMISSIONS FROM A 20 MW (EQUIVALENT) COAL-FIRED(1.7% SULFUR) BOILER. START-UP IS SLATED FOR JANUARY 1979.
QUALITY MILLS, INC. MT. AIRY, NORTH CAROLINA COMMERCIAL FABRICATION & MACH. OIL 10,000 SCFM (TOTAL - 3 BOILERS) START-UP 5/70 WATER SCRUBBING STATUS - TERMINATED	THIS SMALL INDUSTRIAL BOILER UTILIZED A COMMERICAL FABRICATION AND MACHINE (CFM) SCRUB-AIR SYSTEM TO CONTROL EMISSIONS FROM THE COAL-FIRED BOILER FROM MAY 1970 TO DECEMBER 1973. AT THAT TIME THEY CONVERTED TO FIRING LOW-SULFUR OIL, REMOVING THE NEED TO CONTROL EMISSIONS.
RICKENBACKER AIR FORCE BASE COLUMBUS, OHIO RESEARCH-COTTRELL/BAHCO COAL (3.6% SULFUR) 55,000 SCFM (TOTAL - 7 BOILERS) START-UP 3/76 LIMESTONE SCRUBBING STATUS - OPERATIONAL	THIS RESEARCH-COTTRELL/BAHCO LIME FGD UNIT WAS FIRST PLACED IN SERVICE MARCH 11, 1976. THE SYSTEM WAS SWITCHED OVER TO LIMESTONE IN APRIL 1977, AND HAS REMAINED IN THAT OPERATING MODE TO DATE. AN AVAILABILITY OF 99.5% WAS REPORTED FOR THIS PERIOD. DURING THIS REPORT PERIOD THE SCRUBBER WAS INSPECTED AND FOUND TO BE FAIRLY FREE OF CORROSION AND SCALING.
SHELL OIL COMPANY BAKERSFIELD, CALIFORNIA VENDOR NOT SELECTED OIL (1.1% SULFUR) 99,000 SCFM (TOTAL - 8 BOILERS) START-UP 0/ 0 PROCESS NOT SELECTED STATUS - PLANNED-CONSIDERING SO2 CONTROL	SHELL OIL IS CONSIDERING IMPLEMENTING FGD TECHNOLOGY TO CONTROL EMISSIONS FROM 8 SMALL OIL- FIRED (1.1% SULFUR) STEAM GENERATORS. NO PROCESS OR START-UP DATE HAVE AS YET BEEN SPECIFIED. AN SO2 REMOVAL EFFICIENCY OF 94% WILL BE REQUIRED.
SHELL OIL COMPANY TAFT, CALIFORNIA VENDOR NOT SELECTED OIL (1.1% SULFUR) 25,000 SCFM (TOTAL - 2 BOILERS) START-UP 0/ 0 PROCESS NOT SELECTED STATUS - PLANNED-CONSIDERING SO2 CONTROL	SHELL OIL IS CONSIDERING IMPLEMENTING FGD TECHNOLOGY TO CONTROL EMISSIONS FROM 2 SMALL OIL-FIRED (1.1% SULFUR) STEAM GENERATORS. NO PROCESS OR START-UP DATE HAVE AS YET BEEN SPECIFIED. AN SO2 REMOVAL EFFICIENCY OF 94% WILL BE REQUIRED.

SECTION 5 (CONTINUED)

SUMMARY OF FGD SYSTEMS ON INDUSTRIAL BOILERS

COMPANY INFORMATION	SUMMARY OF RECENT OPERATIONS
SHELLER GLOBE CORP. NORFOLK, VIRGINIA W.W. SLY MANUFACTURING CO. COAL (< 1.0% SULFUR) 8,000 SCFM (TOTAL - 1 BOILER) START-UP 0/75 SODIUM HYDROXIDE SCRUBBING STATUS - OPERATIONAL	AFTER SYSTEM RESTART IN OCTOBER 1977, THERE HAVE BEEN NO PROBLEMS RESULTING FROM EITHER BOILER OR SCRUBBER OPERATIONS. THE PLANT UNDERWENT A VIRGINIA EPA INSPECTION AND WAS FOUND TO BE IN COMPLIANCE WITH THE PARTICULATE EMISSION REGULATIONS. NO SCRUBBER-RELATED PROBLEMS HAVE OCCURRED DURING THIS REPORT PERIOD.
ST. JOE ZINC CO. MONACA, PENNSYLVANIA BUREAU OF MINES COAL (2.5% - 4.5% SULFUR) 104,000 SCFM (TOTAL - 1 BOILER) START-UP 12/78 CITRATE PROCESS STATUS - CONSTRUCTION	CONSTRUCTION CONTINUES ON THE CITRATE PROCESS SCRUBBING SYSTEM WHICH WILL CONTROL SO2 EMISSIONS FROM A 60-MW (NOMINAL PEAK CAPACITY) COAL-FIRED POWER GENERATING UNIT. STARTUP WILL BE DEC. 1978. THIS SYSTEM WILL ALSO BE REPORTED IN THE EPA/PEDCO UTILITY FGD SURVEY, SINCE THE SYSTEM WILL BE OPERATED WITH A UTILITY-TYPE LOAD PROFILE, DURING THE ONE-YEAR DEMONSTRATION PERIOD.
ST. REGIS PAPER CO. CANTONMENT, FLORIDA AIRPOL INDUSTRIES BARK,OIL/GAS (< 1.0% SULFUR) 115,000 SCFM (1 BOILER) START-UP 0/73 CAUSTIC SCRUBBING STATUS - OPERATIONAL	AIRPOL HAS SUPPLIED THE CAUSTIC SCRUBBING FGD SYSTEM TO REMOVE PARTICULATE AND SULFUR DIOXIDE FROM THE FLUE GAS OF A BARK BOILER, WHICH CAN ALSO FIRE NATURAL GAS AND OIL. PLANT HAS NOT YET CHANGED THE FEED WATER SOURCE TO ALLEVIATE PROBLEMS DUE TO FIBERS PLUGGING LINES AND MIST ELIMINATOR. THE SCRUBBER EXHIBITED 100% AVAILABILITY. BOILER OPERATION WAS 4888 HRS.
TEXACO INCORPORATED SAN ARDO, CALIFORNIA CEILCOTE OIL (1.7% SULFUR) 366,000 SCFM (TOTAL - 24 BOILERS) START-UP 11/73 SODIUM HYDROXIDE SCRUBBING STATUS - OPERATIONAL	EACH FGD SYSTEM CONSISTS OF A HORIZONTAL, PACKED-BED SCRUBBER FOR EACH OF THE OIL-FIRED BOILERS. POOR SCRUBBING LIQUOR QUALITY CAUSES PLUGGING OF PACKED BEDS AND SPRAY NOZZLES. THE SYSTEMS HAVE HIGH MAINTENANCE REQUIREMENTS AND RELATIVELY LOW SO2 REMOVAL (73%). TEXACO IS PLANNING TO PHASE OUT THIS GROUP OF SCRUBBERS BY LATE 1979. AVAILABILITY OF THE SCUBBER FOR THIS PERIOD WAS APPROXIMATELY 94%.
TEXACO INCORPORATED SAN ARDO, CALIFORNIA DUCON COMPANY OIL (1.7% SULFUR) 117,000 SCFM (TOTAL - 9 BOILERS) START-UP 3/79 SODIUM HYDROXIDE SCRUBBING STATUS - CONSTRUCTION	TEXACO IS PLANNING TO PHASE OUT THE EXISTING FGD SYSTEMS AT THEIR SAN ARDO, CALIFORNIA OIL SITE. AS THE FIRST STEP OF THE PROGRAM, 9 OF THE PRESENT 31 SCRUBBERS ON 50 MM BTU/HR STEAM GENERATORS ARE BEING REPLACED BY A NEW SYSTEM, SUPPLIED BY DUCON COMPANY. THE NEW FGD SYSTEM WILL CONSIST OF THREE TRAINS OF A VENTURI SCRUBBER/SPRAY ABSORBER COMBINATION. TEXACO HAS TAKEN DELIVERY ON ONE UNIT, WITH DELIVERY ON THE OTHER UNITS EXPECTED SOON.
TEXASGULF GRANGER, WYOMING SWEMCO INC. OIL (1.1% SULFUR) 140,000 SCFM (TOTAL - 2 BOILERS) START-UP 9/76 SODIUM CARBONATE SCRUBBING STATUS - OPERATIONAL	THIS SODIUM CARBONATE SCRUBBING SYSTEM WAS DESIGNED BY SWEMCO. SO2 ABSORPTION OCCURS IN THE QUENCHER AND THE SIEVE-TRAY ABSORBER MODULE. AN INTERESTING FEATURE IS AN INTERNAL DAMPER WHICH ALLOWS A 4 TO 1 TURNDOWN RATIO. TWO SCHEDULED INSPECTION OUTAGES OCCURRED DURING THIS PERIOD. SOME MINOR PLUGGING WAS REPORTED.
TRANSCO TEXTILES, INC. AUGUSTA, GEORGIA FMC ENVIRONMENTAL EQUIPMENT FUEL OIL (2% MAX. SULFUR) 50,000 ACFM START-UP 3/75 SODIUM CARBONATE SCRUBBING STATUS - INDEFINITELY SHUT DOWN	THE FGD OPERATIONS HAVE BEEN TERMINATED FOR AN INDEFINITE PERIOD. THE PLANT BURNS NUMBER 6 FUEL OIL AND THE SULFUR DIOXIDE EMISSIONS ARE 50% OF THE EXISTING REGULATIONS. THE BOILER IS RATED AT 20 MW (EQUIVALENT) AND PRODUCES 150,000 LBS/HR STEAM. WHEN OPERATIONAL, THE SCRUBBER SYSTEM HAD A FLUE GAS VOLUME OF 50,000 ACFM AT 140 DEGREES F. SYSTEM START-UP OCCURRED IN MARCH 1975 AND SCRUBBER OPERATIONS WERE TERMINATED LATER IN THE SAME YEAR. THERE ARE CURRENTLY NO PLANS TO INITIATE OPERATIONS.

SECTION 3 (CONTINUED)

SUMMARY OF FGD SYSTEMS ON INDUSTRIAL BOILERS

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COMPANY INFORMATION                                  SUMMARY OF RECENT OPERATIONS
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U.S. GYPSUM CORP.                                    AN AIRPOL DOUBLE ALKALI SCRUBBING SYSTEM IS
OAKMONT, PENNSYLVANIA                                ON-SITE, INSTALLED, AND READY FOR OPERATIONS.
AIRPOL INDUSTRIES                                    HOWEVER, US GYPSUM DECIDED NOT TO INITIATE
COAL                                                 PRODUCTION AT THIS FACILITY FOR ECONOMIC REASONS.
19,300 SCFM (TOTAL - 4 BOILERS)                      A CHECK DURING THIS REPORT PERIOD REVEALED THAT
START-UP    0/ 0                                     THE PLANT HAS NOT BEEN STARTED YET.
DOUBLE ALKALI (DILUTE)
STATUS - NEVER STARTED-UP
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SECTION 4

SUMMARY BY VENDOR OF FGD SYSTEMS ON INDUSTRIAL BOILERS

VENDOR	INSTALLATION NAME / LOCATION	CONTROL SYSTEM PROCESS
A.D. LITTLE	GENERAL MOTORS CORPORATION ST. LOUIS, MISSOURI	SODIUM HYDROXIDE SCRUBBING
AIRPOL INDUSTRIES	GEORGIA-PACIFIC PAPER CO. CROSSETT, ARKANSAS	CAUSTIC WASTE STREAM
	GREAT SOUTHERN PAPER CO. CEDAR SPRINGS, GEORGIA	CAUSTIC WASTE STREAM
	ITT RAYONIER, INC. FERNANDINA BEACH, FLORIDA	SODIUM HYDROXIDE SCRUBBING
	MEAD PAPERBOARD CO. STEVENSON, ALABAMA	SODIUM HYDROXIDE SCRUBBING
	NEKOOSA PAPERS, INC. ASHDOWN, ARKANSAS	CAUSTIC SCRUBBING
	ST. REGIS PAPER CO. CANTONMENT, FLORIDA	CAUSTIC SCRUBBING
	U.S. GYPSUM CORP. OAKMONT, PENNSYLVANIA	DOUBLE ALKALI (DILUTE)
BUREAU OF MINES	ST. JOE ZINC CO. MONACA, PENNSYLVANIA	CITRATE PROCESS
C-E NATCO	BELRIDGE OIL CO. MCKITTRICK, CALIFORNIA	SODIUM HYDROXIDE SCRUBBING
CARBORUNDUM ENVIR. SYS. LTD.	CARBORUNDUM ABRASIVES BUFFALO, NEW YORK	LIME SCRUBBING
CEILCOTE	TEXACO INCORPORATED SAN ARDO, CALIFORNIA	SODIUM HYDROXIDE SCRUBBING
COMBUSTION EQUIPMENT ASSOC.	KERR-MCGEE CHEMICAL CORP. TRONA, CALIFORNIA	SODIUM CARBONATE SCRUBBING
COMMERCIAL FABRICATION & MACH.	QUALITY MILLS, INC. MT. AIRY, NORTH CAROLINA	WATER SCRUBBING
DRAVO CORP./NAT'L LIME ASS'N	BUNGE, INC. CAIRO, ILLINOIS	LIME SCRUBBING
DUCON COMPANY	TEXACO INCORPORATED SAN ARDO, CALIFORNIA	SODIUM HYDROXIDE SCRUBBING
ENTOLETER, INC.	GENERAL MOTORS CORPORATION DAYTON, OHIO	SODIUM HYDROXIDE SCRUBBING
FLAKT, INC.	PHILLIP MORRIS, INC. CHESTER, VA.	SODIUM CARBONATE SCRUBBING
FMC ENVIRONMENTAL EQUIPMENT	ALYESKA PIPELINE SERVICE CO. VALDEZ, ALASKA	SODIUM HYDROXIDE SCRUBBING
	ARCO/POLYMERS, INC. MONACA, PENNSYLVANIA	DOUBLE ALKALI (CONCENTRATED)
	CANTON TEXTILES CANTON, GEORGIA	CAUSTIC WASTE STREAM
	CATERPILLAR TRACTOR CO. EAST PEORIA, ILLINOIS	DOUBLE ALKALI (CONCENTRATED)
	CATERPILLAR TRACTOR CO. MAPLETON, ILLINOIS	DOUBLE ALKALI (CONCENTRATED)

SECTION 4 (CONTINUED)

SUMMARY BY VENDOR OF FGD SYSTEMS ON INDUSTRIAL BOILERS

VENDOR	INSTALLATION NAME / LOCATION	CONTROL SYSTEM PROCESS
FMC ENVIRONMENTAL EQUIPMENT	CATERPILLAR TRACTOR CO. MAPLETON, ILLINOIS	DOUBLE ALKALI (CONCENTRATED)
	CATERPILLAR TRACTOR CO. MOSSVILLE, ILLINOIS	DOUBLE ALKALI (CONCENTRATED)
	CHANSLOR WESTERN OIL & DEV. CO BAKERSFIELD, CALIFORNIA	DOUBLE ALKALI (CONCENTRATED)
	FIRESTONE TIRE AND RUBBER CO. POTTSTOWN, PENNSYLVANIA	DOUBLE ALKALI (CONCENTRATED)
	FMC (SODA ASH PLANT) GREEN RIVER, WYOMING	SODIUM CARBONATE SCRUBBING
	GENERAL MOTORS CORPORATION TONOWANDA, NEW YORK	SODIUM HYDROXIDE SCRUBBING
	GETTY OIL COMPANY BAKERSFIELD, CALIFORNIA	SODIUM CARBONATE SCRUBBING
	TRANSCO TEXTILES, INC. AUGUSTA, GEORGIA	SODIUM CARBONATE SCRUBBING
GM ENVIRONMENTAL	GENERAL MOTORS CORPORATION PARMA, OHIO	DOUBLE ALKALI (DILUTE)
GREAT WESTERN SUGAR	GREAT WESTERN SUGAR BILLINGS, MONTANA	AMMONIA-LADEN PROCESS WATER
	GREAT WESTERN SUGAR FINDLAY, OHIO	SODIUM CARBONATE SCRUBBING
	GREAT WESTERN SUGAR FORT MORGAN, COLORADO	AMMONIA-LADEN PROCESS WATER
	GREAT WESTERN SUGAR FREEMONT, OHIO	SODIUM CARBONATE SCRUBBING
	GREAT WESTERN SUGAR GERING, NEBRASKA	AMMONIA-LADEN PROCESS WATER
	GREAT WESTERN SUGAR GREELEY, COLORADO	AMMONIA-LADEN PROCESS WATER
	GREAT WESTERN SUGAR LONGMONT, COLORADO	AMMONIA-LADEN PROCESS WATER
	GREAT WESTERN SUGAR LOVELAND, COLORADO	AMMONIA-LADEN PROCESS WATER
	GREAT WESTERN SUGAR SCOTTS BLUFF, NEBRASKA	AMMONIA-LADEN PROCESS WATER
HEATER TECHNOLOGY	BELRIDGE OIL COMPANY MCKITTRICK, CALIFORNIA	SODIUM HYDROXIDE SCRUBBING
	MOBIL OIL COMPANY BUTTONWILLOW, CALIFORNIA	SODIUM CARBONATE SCRUBBING
KOCH ENGINEERING	ARMCO STEEL MIDDLETOWN, OHIO	LIME SCRUBBING
	CHEVRON U.S.A. INC. BAKERSFIELD, CALIFORNIA	SODIUM CARBONATE SCRUBBING
	CHEVRON U.S.A. INC. BAKERSFIELD, CALIFORNIA	SODIUM CARBONATE SCRUBBING

SECTION 4 (CONTINUED)

SUMMARY BY VENDOR OF FGD SYSTEMS ON INDUSTRIAL BOILERS

VENDOR	INSTALLATION NAME / LOCATION	CONTROL SYSTEM PROCESS
KOCH ENGINEERING	MINN-DAK FARMER'S COOPERATIVE WAHPETON, NORTH DAKOTA	AMMONIA SCRUBBING
MOBIL OIL COMPANY	MOBIL OIL CORPORATION SAN ARDO, CALIFORNIA	SODIUM HYDROXIDE SCRUBBING
PEABODY ENGINEERING	GENERAL MOTORS CORPORATION PONTIAC, MICHIGAN	SODIUM HYDROXIDE SCRUBBING
PROPRIETARY DESIGN	GETTY OIL COMPANY BAKERSFIELD, CALIFORNIA	SODIUM CARBONATE SCRUBBING
RESEARCH-COTTRELL/BAHCO	RICKENBACKER AIR FORCE BASE COLUMBUS, OHIO	LIMESTONE SCRUBBING
SWEMCO INC.	TEXASGULF GRANGER, WYOMING	SODIUM CARBONATE SCRUBBING
THERMOTICS INC.	BELRIDGE OIL CO. MCKITTRICK, CALIFORNIA	SODIUM HYDROXIDE SCRUBBING
VENDOR NOT SELECTED	C.A.M.(CARBIDE-AMOCO-MONSANTO) HOUSTON, TEXAS	PROCESS NOT SELECTED
	DUPONT, INC. GEORGIA	DOUBLE ALKALI
	DUPONT, INC. TEXAS	LIMESTONE SCRUBBING
	GRISSOM AIR FORCE BASE BUNKER HILL, INDIANA	DOUBLE ALKALI (CONCENTRATED)
	SHELL OIL COMPANY BAKERSFIELD, CALIFORNIA	PROCESS NOT SELECTED
	SHELL OIL COMPANY TAFT, CALIFORNIA	PROCESS NOT SELECTED
W.W. SLY MANUFACTURING CO.	AMERICAN THREAD CO. MARION, NORTH CAROLINA	CAUSTIC WASTE STREAM
	HARRIS MINING CO. SPRUCE PINE, NORTH CAROLINA	WATER SCRUBBING (NA,NH3 OPTN.)
	SHELLER GLOBE CORP. NORFOLK, VIRGINIA	SODIUM HYDROXIDE SCRUBBING
ZURN INDUSTRIES	CATERPILLAR TRACTOR CO. JOLIET, ILLINOIS	DOUBLE ALKALI (DILUTE)
	CATERPILLAR TRACTOR CO. MORTON, ILLINOIS	DOUBLE ALKALI (DILUTE)

STATUS TO OCTOBER 1978

SECTION 5

OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

COMPANY/LOCATION/FUEL	NEW/ RETROFIT	UNIT SIZE (SCFM)	PROCESS/VENDOR	START-UP MO/YR
ALYESKA PIPELINE SERVICE CO. VALDEZ, ALASKA OIL (0.03% - 0.1% SULFUR)	NEW	50,000	SODIUM HYDROXIDE SCRUBBING FMC ENVIRONMENTAL EQUIPMENT	6/77
AMERICAN THREAD CO. MARION, NORTH CAROLINA COAL (1 - 1.5% SULFUR)	RETROFIT	18,500	CAUSTIC WASTE STREAM W.W. SLY MANUFACTURING CO.	0/73
ARMCO STEEL MIDDLETOWN, OHIO COAL (0.8% SULFUR)	RETROFIT	84,000	LIME SCRUBBING KOCH ENGINEERING	0/75
BELRIDGE OIL CO. MCKITTRICK, CALIFORNIA CRUDE OIL (1.1% SULFUR)	NEW	12,000	SODIUM HYDROXIDE SCRUBBING THERMOTICS INC.	7/78
BELRIDGE OIL COMPANY MCKITTRICK, CALIFORNIA OIL (1.1% SULFUR)	NEW	12,000	SODIUM HYDROXIDE SCRUBBING HEATER TECHNOLOGY	6/78
CANTON TEXTILES CANTON, GEORGIA COAL (0.8% SULFUR) INTERRUPTIBLE NATURAL GAS	RETROFIT	25,000	CAUSTIC WASTE STREAM FMC ENVIRONMENTAL EQUIPMENT	6/74
CATERPILLAR TRACTOR CO. EAST PEORIA, ILLINOIS COAL (3.2% SULFUR)	2 NEW, 2 RETRO	210,000	DOUBLE ALKALI (CONCENTRATED) FMC ENVIRONMENTAL EQUIPMENT	4/78
CATERPILLAR TRACTOR CO. MOSSVILLE, ILLINOIS COAL (3.2% SULFUR)	1 NEW 1 RETRO	140,000	DOUBLE ALKALI (CONCENTRATED) FMC ENVIRONMENTAL EQUIPMENT	10/75
CATERPILLAR TRACTOR CO. JOLIET, ILLINOIS COAL (3.2% SULFUR)	RETROFIT	67,000	DOUBLE ALKALI (DILUTE) ZURN INDUSTRIES	9/74
CATERPILLAR TRACTOR CO. MORTON, ILLINOIS COAL (3.2% SULFUR)	RETROFIT	40,000	DOUBLE ALKALI (DILUTE) ZURN INDUSTRIES	1/78
CHEVRON U.S.A. INC. BAKERSFIELD, CALIFORNIA OIL (1.1% SULFUR)	RETROFIT	248,000	SODIUM CARBONATE SCRUBBING KOCH ENGINEERING	7/78
FIRESTONE TIRE AND RUBBER CO. POTTSTOWN, PENNSYLVANIA COAL (2.5 - 3.0% SULFUR)	RETROFIT	8070	DOUBLE ALKALI (CONCENTRATED) FMC ENVIRONMENTAL EQUIPMENT	1/75
FMC (SODA ASH PLANT) GREEN RIVER, WYOMING COAL (1% SULFUR)	NEW	446,000	SODIUM CARBONATE SCRUBBING FMC ENVIRONMENTAL EQUIPMENT	5/76

SECTION 5 (CONTINUED)

OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

COMPANY/LOCATION/FUEL	NEW/ RETROFIT	UNIT SIZE (SCFM)	PROCESS/VENDOR	START-UP MO/YR
GENERAL MOTORS CORPORATION ST. LOUIS, MISSOURI COAL (3.2% SULFUR)	RETROFIT	64,000	SODIUM HYDROXIDE SCRUBBING A.D. LITTLE	0/72
GENERAL MOTORS CORPORATION DAYTON, OHIO COAL(0.7% - 2.0% SULFUR)	RETROFIT	36,000	SODIUM HYDROXIDE SCRUBBING ENTOLETER, INC.	9/74
GENERAL MOTORS CORPORATION TONOWANDA, NEW YORK COAL (1.2% SULFUR)	RETROFIT	92,000	SODIUM HYDROXIDE SCRUBBING FMC ENVIRONMENTAL EQUIPMENT	6/75
GENERAL MOTORS CORPORATION PARMA, OHIO COAL (2.5% SULFUR)	RETROFIT	128,400	DOUBLE ALKALI (DILUTE) GM ENVIRONMENTAL	3/74
GENERAL MOTORS CORPORATION PONTIAC, MICHIGAN COAL (0.84% SULFUR) ALSO WOOD, PAPER, AND CARDBOARD.	NEW	107,300	SODIUM HYDROXIDE SCRUBBING PEABODY ENGINEERING	4/76
GEORGIA-PACIFIC PAPER CO. CROSSETT, ARKANSAS BARK,COAL/OIL (1% - 1.5% SULFUR)	NEW	220,000	CAUSTIC WASTE STREAM AIRPOL INDUSTRIES	0/75
GETTY OIL COMPANY BAKERSFIELD, CALIFORNIA COAL (1.1% SULFUR)	RETROFIT	72,000	SODIUM CARBONATE SCRUBBING FMC ENVIRONMENTAL EQUIPMENT	6/77
GREAT SOUTHERN PAPER CO. CEDAR SPRINGS, GEORGIA BARK,COAL/OIL (1.0% - 2.0% SULFUR)	RETROFIT	420,000	CAUSTIC WASTE STREAM AIRPOL INDUSTRIES	0/75
GREAT WESTERN SUGAR BILLINGS, MONTANA COAL (0.7% SULFUR)	RETROFIT	60,000	AMMONIA-LADEN PROCESS WATER GREAT WESTERN SUGAR	10/77
GREAT WESTERN SUGAR FINDLAY, OHIO COAL (1.2% SULFUR, AVERAGE)	RETROFIT	65,230	SODIUM CARBONATE SCRUBBING GREAT WESTERN SUGAR	10/74
GREAT WESTERN SUGAR FORT MORGAN, COLORADO COAL (1.2% SULFUR, AVERAGE)	RETROFIT	65,230	AMMONIA-LADEN PROCESS WATER GREAT WESTERN SUGAR	10/76
GREAT WESTERN SUGAR GERING, NEBRASKA COAL (1.2% SULFUR, AVERAGE)	RETROFIT	110,000	AMMONIA-LADEN PROCESS WATER GREAT WESTERN SUGAR	10/75
GREAT WESTERN SUGAR GREELEY, COLORADO COAL (0.6% SULFUR)	RETROFIT	25,000	AMMONIA-LADEN PROCESS WATER GREAT WESTERN SUGAR	10/75

SECTION 5 (CONTINUED)

OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

COMPANY/LOCATION/FUEL	NEW/ RETROFIT	UNIT SIZE (SCFM)	PROCESS/VENDOR	START-UP MO/YR
GREAT WESTERN SUGAR LOVELAND, COLORADO COAL (1.2% SULFUR, AVERAGE)	RETROFIT	121,800	AMMONIA-LADEN PROCESS WATER GREAT WESTERN SUGAR	10/73
GREAT WESTERN SUGAR SCOTTS BLUFF, NEBRASKA COAL (1.2% SULFUR, AVERAGE)	RETROFIT	65,230	AMMONIA-LADEN PROCESS WATER GREAT WESTERN SUGAR	10/75
ITT RAYONIER, INC. FERNANDINA BEACH, FLORIDA BARK,OIL (2.0% - 2.5% SULFUR)	RETROFIT	201,000	SODIUM HYDROXIDE SCRUBBING AIRPOL INDUSTRIES	0/75
KERR-MCGEE CHEMICAL CORP. TRONA, CALIFORNIA COKE/COAL/OIL (0.5% - 5.0% SULFUR)	NEW	490,000	SODIUM CARBONATE SCRUBBING COMBUSTION EQUIPMENT ASSOC.	6/78
MEAD PAPERBOARD CO. STEVENSON, ALABAMA OIL (1.5% - 3% SULFUR)	NEW	100,000	SODIUM HYDROXIDE SCRUBBING AIRPOL INDUSTRIES	0/75
MINN-DAK FARMER'S COOPERATIVE WAHPETON, NORTH DAKOTA LIGNITE (1.0% SULFUR)	RETROFIT	160,000	AMMONIA SCRUBBING KOCH ENGINEERING	6/77
MOBIL OIL CORPORATION SAN ARDO, CALIFORNIA OIL (2.0% - 2.25% SULFUR)	RETROFIT	182,000	SODIUM HYDROXIDE SCRUBBING MOBIL OIL COMPANY	0/74
NEKOOSA PAPERS, INC. ASHDOWN, ARKANSAS COAL (1% - 1.5% SULFUR)	NEW	211,000	CAUSTIC SCRUBBING AIRPOL INDUSTRIES	2/76
RICKENBACKER AIR FORCE BASE COLUMBUS, OHIO COAL (3.6% SULFUR)	RETROFIT	55,000	LIMESTONE SCRUBBING RESEARCH-COTTRELL/BAHCO	3/76
SHELLER GLOBE CORP. NORFOLK, VIRGINIA COAL (< 1.0% SULFUR)	RETROFIT	8,000	SODIUM HYDROXIDE SCRUBBING W.W. SLY MANUFACTURING CO.	0/75
ST. REGIS PAPER CO. CANTONMENT, FLORIDA BARK,OIL/GAS (< 1.0% SULFUR)	RETROFIT	115,000	CAUSTIC SCRUBBING AIRPOL INDUSTRIES	0/73
TEXACO INCORPORATED SAN ARDO, CALIFORNIA OIL (1.7% SULFUR)	RETROFIT	366,000	SODIUM HYDROXIDE SCRUBBING CEILCOTE	11/73
TEXASGULF GRANGER, WYOMING OIL (1.1% SULFUR)	NEW	140,000	SODIUM CARBONATE SCRUBBING SWEMCO INC.	9/76

SECTION 6

UNDER CONSTRUCTION FGD SYSTEMS ON INDUSTRIAL BOILERS

COMPANY/LOCATION/FUEL	NEW/ RETROFIT	UNIT SIZE (SCFM)	PROCESS/VENDOR	START-UP MO/YR
BELRIDGE OIL CO. MCKITTRICK, CALIFORNIA CRUDE OIL (1.1% SULFUR)	RETROFIT	12,000	SODIUM HYDROXIDE SCRUBBING C-E NATCO	11/78
CATERPILLAR TRACTOR CO. MAPLETON, ILLINOIS COAL (3.2% SULFUR)	NEW	157,000	DOUBLE ALKALI (CONCENTRATED) FMC ENVIRONMENTAL EQUIPMENT	10/78
CATERPILLAR TRACTOR CO. MAPLETON, ILLINOIS COAL (3.2% SULFUR)	NEW	262,000	DOUBLE ALKALI (CONCENTRATED) FMC ENVIRONMENTAL EQUIPMENT	10/79
CHANSLOR WESTERN OIL & DEV. CO BAKERSFIELD, CALIFORNIA OIL (1.5% SULFUR)	NEW	70,000	DOUBLE ALKALI (CONCENTRATED) FMC ENVIRONMENTAL EQUIPMENT	12/78
GETTY OIL COMPANY BAKERSFIELD, CALIFORNIA OIL (1.1% SULFUR)	RETROFIT	993,750	SODIUM CARBONATE SCRUBBING PROPRIETARY DESIGN	12/78
GREAT WESTERN SUGAR FREEMONT, OHIO COAL (3% SULFUR)	RETROFIT	40,000	SODIUM CARBONATE SCRUBBING GREAT WESTERN SUGAR	10/78
MOBIL OIL COMPANY BUTTONWILLOW, CALIFORNIA OIL (1.1% SULFUR)	RETROFIT	42,000	SODIUM CARBONATE SCRUBBING HEATER TECHNOLOGY	9/78
PHILLIP MORRIS, INC. CHESTER, VA. COAL (1.7% SULFUR)	NEW	39,000	SODIUM CARBONATE SCRUBBING FLAKT, INC.	1/79
ST. JOE ZINC CO. MONACA, PENNSYLVANIA COAL (2.5% - 4.5% SULFUR)	RETROFIT	104,000	CITRATE PROCESS BUREAU OF MINES	12/78
TEXACO INCORPORATED SAN ARDO, CALIFORNIA OIL (1.7% SULFUR)	RETROFIT	117,000	SODIUM HYDROXIDE SCRUBBING DUCON COMPANY	3/79

SECTION 7

PLANNED FGD SYSTEMS ON INDUSTRIAL BOILERS

COMPANY/LOCATION/FUEL	NEW/ RETROFIT	UNIT SIZE (SCFM)	PROCESS/VENDOR	START-UP MO/YR
ARCO/POLYMERS, INC. MONACA, PENNSYLVANIA COAL (3.0% SULFUR)	RETROFIT	236,000	DOUBLE ALKALI (CONCENTRATED) FMC ENVIRONMENTAL EQUIPMENT	6/80
CARBORUNDUM ABRASIVES BUFFALO, NEW YORK COAL (2.2% SULFUR)	RETROFIT	30,000	LIME SCRUBBING CARBORUNDUM ENVIR. SYS. LTD.	0/ 0
CHEVRON U.S.A. INC. BAKERSFIELD, CALIFORNIA OIL (1.1% SULFUR)	RETROFIT	146,000	SODIUM CARBONATE SCRUBBING KOCH ENGINEERING	4/79
GRISSOM AIR FORCE BASE BUNKER HILL, INDIANA COAL (0.9% - 4.6% SULFUR)	1 NEW 2 RETRO	32,000	DOUBLE ALKALI (CONCENTRATED) VENDOR NOT SELECTED	9/79
C.A.M.(CARBIDE-AMOCO-MONSANTO) HOUSTON, TEXAS FUEL NOT SELECTED	NEW	1,200,000	PROCESS NOT SELECTED VENDOR NOT SELECTED	10/83
DUPONT, INC. GEORGIA COAL (1.5% SULFUR)	NEW	280,000	DOUBLE ALKALI VENDOR NOT SELECTED	0/87
DUPONT, INC. TEXAS COAL (0.5% SULFUR)	NEW	320,000	LIMESTONE SCRUBBING VENDOR NOT SELECTED	0/82
SHELL OIL COMPANY BAKERSFIELD, CALIFORNIA OIL (1.1% SULFUR)	NEW	99,000	PROCESS NOT SELECTED VENDOR NOT SELECTED	0/ 0
SHELL OIL COMPANY TAFT, CALIFORNIA OIL (1.1% SULFUR)	NEW	25,000	PROCESS NOT SELECTED VENDOR NOT SELECTED	0/ 0

SECTION 8

SUMMARY OF DISPOSAL PRACTICES FOR FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME / LOCATION	STATUS/COMMENTS
ALKALINE SULFITE/BISULFITE RECYCLED TO PULP PROCESS	
MEAD PAPERBOARD CO. STEVENSON, ALABAMA	OPERATIONAL RECOVERED SOLUTION USED AS MAKE-UP TO COOKING LIQUOR IN PULP MILL.
NEKOOSA PAPERS, INC. ASHDOWN, ARKANSAS	OPERATIONAL SO_2 RECOVERED FROM SODIUM SULFITE/SULFATE LIQUOR AND RECYCLED TO PULPING PROCESS.
DEWATERED SLURRY TO LANDFILL	
ARCO/POLYMERS, INC. MONACA, PENNSYLVANIA	PLANNED-CONTRACT AWARDED FLYASH ADDITION TO DEWATERED $CASO_3/CASO_4$ FILTER CAKE, THEN TO LANDFILL.
BUNGE, INC. CAIRO, ILLINOIS	INDEFINITELY SHUT DOWN
CATERPILLAR TRACTOR CO. EAST PEORIA, ILLINOIS	OPERATIONAL 60+% SOLIDS ($CASO_4$) SLUDGE DIRECTLY TO LANDFILL
CATERPILLAR TRACTOR CO. MOSSVILLE, ILLINOIS	OPERATIONAL 60+% SOLIDS ($CASO_4$) SLUDGE DIRECTLY TO LANDFILL
CATERPILLAR TRACTOR CO. JOLIET, ILLINOIS	OPERATIONAL
CATERPILLAR TRACTOR CO. MORTON, ILLINOIS	OPERATIONAL
CATERPILLAR TRACTOR CO. MAPLETON, ILLINOIS	CONSTRUCTION 60+% SOLIDS ($CASO_4$) SLUDGE DIRECTLY TO LANDFILL
CATERPILLAR TRACTOR CO. MAPLETON, ILLINOIS	CONSTRUCTION 60+% SOLIDS ($CASO_4$) SLUDGE DIRECTLY TO LANDFILL.
CHANSLOR WESTERN OIL & DEV. CO BAKERSFIELD, CALIFORNIA	CONSTRUCTION
DUPONT, INC. GEORGIA	PLANNED-CONSIDERING SO_2 CONTROL
DUPONT, INC. TEXAS	PLANNED-CONSIDERING SO_2 CONTROL
FIRESTONE TIRE AND RUBBER CO. POTTSTOWN, PENNSYLVANIA	OPERATIONAL
GENERAL MOTORS CORPORATION TONOWANDA, NEW YORK	OPERATIONAL FLY ASH AND NA_2SO_3/SO_4 WASTE LIQUOR DEWATERED AND THEN TO SANITARY LANDFILL
GENERAL MOTORS CORPORATION PARMA, OHIO	OPERATIONAL 50+% SOLIDS ($CASO_3/SO_4$) SLUDGE TO DRYING POND AND LANDFILL
GENERAL MOTORS CORPORATION PONTIAC, MICHIGAN	OPERATIONAL 5% SOLIDS SLURRY DEWATERED AND TO LANDFILL
GRISSOM AIR FORCE BASE BUNKER HILL, INDIANA	PLANNED-REQUESTING/EVALUATING BIDS
U.S. GYPSUM CORP. OAKMONT, PENNSYLVANIA	NEVER STARTED-UP SLUDGE TO POND FOR DRYING, THEN TO LANDFILL.

SUMMARY OF DISPOSAL PRACTICES FOR FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME / LOCATION	STATUS/COMMENTS
HOLDING POND FOR EVAPORATION	
AMERICAN THREAD CO. MARION, NORTH CAROLINA	OPERATIONAL THE SODIUM SULFITE/SULFATE WASTE LIQUOR IS PUMPED TO A RED CLAY LINED ASH BASIN. LEACHING OF THE SOLUBLE SODIUM SALTS IS THEREBY PREVENTED.
ARMCO STEEL MIDDLETOWN, OHIO	OPERATIONAL
FMC (SODA ASH PLANT) GREEN RIVER, WYOMING	OPERATIONAL NA2SO3/SO4 LIQUOR DISPOSED TO COLLECTION POND - NO PRIOR AERATION. LANDFILL IN THE FUTURE
GETTY OIL COMPANY BAKERSFIELD, CALIFORNIA	OPERATIONAL 10 GPM BLEEDOFF TO A BLOWDOWN TANK. THE BLOWDOWN IS THEN SENT TO A DISPOSAL POND ONCE A WEEK.
KERR-MCGEE CHEMICAL CORP. TRONA, CALIFORNIA	OPERATIONAL SCRUBBER EFFLUENT IS CLARIFIED AND THEN PUT INTO A MINERAL DEPOSIT.
MOBIL OIL COMPANY BUTTONWILLOW, CALIFORNIA	CONSTRUCTION INTERMITTENT BLOWDOWN TO WASTE DISPOSAL SITE.
MOBIL OIL CORPORATION SAN ARDO, CALIFORNIA	OPERATIONAL
NON-FIXATED SLURRY TO LINED POND	
CANTON TEXTILES CANTON, GEORGIA	OPERATIONAL NA SO3/SO4 LIQUOR DISPOSED TO LINED HOLDING PONDS
RICKENBACKER AIR FORCE BASE COLUMBUS, OHIO	OPERATIONAL UNSTABILIZED CASO3/SO4 SLUDGE TO LINED POND
REGENERABLE - ELEMENTAL SULFUR PRODUCT	
ST. JOE ZINC CO. MONACA, PENNSYLVANIA	CONSTRUCTION
WASTEWATER TREATMENT AND DISCHARGE TO CITY SEWER	
GENERAL MOTORS CORPORATION ST. LOUIS, MISSOURI	OPERATIONAL NA2SO3 OXIDIZED TO NA2SO4, PH NEUTRALIZED AND DISCHARGED TO CITY SEWER SYSTEM
GENERAL MOTORS CORPORATION DAYTON, OHIO	OPERATIONAL NA2SO3/SO4 LIQUOR AT 35 GPM TO ON-SITE CLARIFICATION AND DEWATERING FACILITY
GEORGIA-PACIFIC PAPER CO. CROSSETT, ARKANSAS	OPERATIONAL
GREAT WESTERN SUGAR FINDLAY, OHIO	OPERATIONAL BLEED-OFF STREAM TO HOLDING TANK
GREAT WESTERN SUGAR FREEMONT, OHIO	CONSTRUCTION

SECTION 8 (CONTINUED)

SUMMARY OF DISPOSAL PRACTICES FOR FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME / LOCATION	STATUS/COMMENTS
WASTEWATER TREATMENT AND DISCHARGE TO CITY SEWER	
QUALITY MILLS, INC. MT. AIRY, NORTH CAROLINA	TERMINATED SCRUBBING LIQUOR DISCHARGED TO NEUTRALIZATION POND
WASTEWATER TREATMENT AND DISCHARGE TO RIVER	
GREAT SOUTHERN PAPER CO. CEDAR SPRINGS, GEORGIA	OPERATIONAL CLARIFICATION FOLLOWED BY PONDING AND DISCHARGE TO RIVER
GREAT WESTERN SUGAR BILLINGS, MONTANA	OPERATIONAL
GREAT WESTERN SUGAR FORT MORGAN, COLORADO	OPERATIONAL
GREAT WESTERN SUGAR GERING, NEBRASKA	OPERATIONAL EFFLUENT TO HOLDING POND
GREAT WESTERN SUGAR GREELEY, COLORADO	OPERATIONAL
GREAT WESTERN SUGAR LOVELAND, COLORADO	OPERATIONAL EFFLUENT STREAM TO HOLDING POND
GREAT WESTERN SUGAR SCOTTS BLUFF, NEBRASKA	OPERATIONAL EFFLUENT STREAM TO HOLDING POND.
GREAT WESTERN SUGAR LONGMONT, COLORADO	TERMINATED
TRANSCO TEXTILES, INC. AUGUSTA, GEORGIA	INDEFINITELY SHUT DOWN NA2SO3/SO4 LIQUOR DISCHARGED TO A HOLDING POND
WASTEWATER TREATMENT AND DISCHARGE TO TAILINGS POND	
CHEVRON U.S.A. INC. BAKERSFIELD, CALIFORNIA	OPERATIONAL
GETTY OIL COMPANY BAKERSFIELD, CALIFORNIA	CONSTRUCTION
ITT RAYONIER, INC. FERNANDINA BEACH, FLORIDA	OPERATIONAL
WASTEWATER TREATMENT	
ALYESKA PIPELINE SERVICE CO. VALDEZ, ALASKA	OPERATIONAL NA2SO3/HSO3 AERATED TO NA2SO4 AND TRANSFERRED TO WASTEWATER TREATMENT PLANT AT A RATE OF 10 GPM. IT IS MIXED WITH ABOUT 10,000 GPM OF BALLAST WATER FROM TANKERS IN PORT VALDEZ. CLEANED WATER IS THEN DISCHARGED INTO PORT VALDEZ.
BELRIDGE OIL CO. MCKITTRICK, CALIFORNIA	OPERATIONAL
BELRIDGE OIL COMPANY MCKITTRICK, CALIFORNIA	OPERATIONAL
CARBORUNDUM ABRASIVES BUFFALO, NEW YORK	PLANNED-CONTRACT AWARDED

SECTION 8 (CONTINUED)

SUMMARY OF DISPOSAL PRACTICES FOR FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME / LOCATION	STATUS/COMMENTS
WASTEWATER TREATMENT	
CHEVRON U.S.A. INC. BAKERSFIELD, CALIFORNIA	PLANNED-REQUESTING/EVALUATING BIDS
MINN-DAK FARMER'S COOPERATIVE WAHPETON, NORTH DAKOTA	OPERATIONAL BLEED STREAM GOES TO AN ACTIVATED SLUDGE SYSTEM @ 160 GPM
ST. REGIS PAPER CO. CANTONMENT, FLORIDA	OPERATIONAL EFFLUENT IS TREATED IN AN ON-SITE SEWAGE TREATMENT PLANT
TEXACO INCORPORATED SAN ARDO, CALIFORNIA	OPERATIONAL HALF OF THE SCRUBBER UNDERFLOW IS TREATED AND RECYCLED AS BOILER FEEDWATER; THE OTHER HALF GOES TO WASTEWATER DISPOSAL WELLS.
TEXASGULF GRANGER, WYOMING	OPERATIONAL
OVERFLOW TO SEWER/SLUDGE TO LANDFILL	
SHELLER GLOBE CORP. NORFOLK, VIRGINIA	OPERATIONAL
DISPOSAL TECHNIQUE NOT KNOWN	
C.A.M.(CARBIDE-AMOCO-MONSANTO) HOUSTON, TEXAS	PLANNED-CONSIDERING SO2 CONTROL
HARRIS MINING CO. SPRUCE PINE, NORTH CAROLINA	INDEFINITELY SHUT DOWN
SHELL OIL COMPANY BAKERSFIELD, CALIFORNIA	PLANNED-CONSIDERING SO2 CONTROL
SHELL OIL COMPANY TAFT, CALIFORNIA	PLANNED-CONSIDERING SO2 CONTROL
SCRUBBER EFFLUENT DISPOSED OF IN WASTE WELLS	
TEXACO INCORPORATED SAN ARDO, CALIFORNIA	CONSTRUCTION

SECTION 9

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	ALYESKA PIPELINE SERVICE CO.
INSTALLATION LOCATION	VALDEZ, ALASKA
SOURCE CHARACTERISTICS	OIL (0.03% - 0.1% SULFUR)
SOURCE RATING	50,000 SCFM (DESIGN MAXIMUM)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	3
SOURCE CAPACITY	25 MW (EQUIVALENT)
CONTROL SYSTEM VENDOR	FMC ENVIRONMENTAL EQUIPMENT
CONTROL PROCESS	SODIUM HYDROXIDE SCRUBBING
NEW / RETROFIT	NEW
START-UP DATE	JUNE, 1977
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	96+% (150-160 PPM @ INLET)
PARTICULATE REMOVAL EFFICIENCY	PARTICULATE EMISSIONS MEET NSPS.
WATER MAKE-UP	2 GPM - OPEN LOOP
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT NA2SO3/HSO3 AERATED TO NA2SO4 AND TRANSFERRED TO WASTEWATER TREATMENT PLANT AT A RATE OF 10 GPM. IT IS MIXED WITH ABOUT 10,000 GPM OF BALLAST WATER FROM TANKERS IN PORT VALDEZ. CLEANED WATER IS THEN DISCHARGED INTO PORT VALDEZ.
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

AT THE VALDEZ TERMINAL OF THE ALASKAN OIL PIPELINE, ALYESKA PIPELINE SERVICE COMPANY OPERATES THE OIL STORAGE AND TRANSFER FACILITY. OIL FLOWING IN FROM THE PIPELINE IS TEMPORARILY STORED IN SEVERAL HUGE TANKS, THEN TRANSFERRED FROM THE TANKS TO OIL TANKER SHIPS IN NEARBY PORT VALDEZ. ALYESKA NEEDED NEUTRAL BLANKET AIR FOR THE OIL STORAGE TANKS, A LOW OXYGEN CONTENT BEING PARTICULARLY DESIRABLE. IT WAS DETERMINED THAT ON-SITE BOILER FLUE GAS WOULD HAVE THE REQUIRED LOW OXYGEN CONTENT. CORROSION PREVENTION IN THE OIL STORAGE TANKS DICTATED THE NEED FOR SO2 CONTROLS. THAT IS, THE DEVICE WAS NOT INSTALLED TO MEET AN EMISSIONS REGULATION. NEVERTHELESS, THE "INERT GAS" SYSTEM IS BASICALLY A SODIUM HYDROXIDE FGD SYSTEM AND WAS DESIGNED AND INSTALLED BY FMC ENVIRONMENTAL EQUIPMENT DIVISION.

THE BOILERS DO NOT OPERATE AT STEADY STATE CONDITIONS. THIS IS DUE TO THE FACT THAT WHEN OIL IS REMOVED FROM THE TANKS AT A FASTER RATE THAN IT IS BEING FED BY THE PIPELINE, AN ADDITIONAL INERT AIR BLANKET IS NEEDED. THIS REQUIRES INCREASING THE BOILER LOAD FROM THE NORMAL LEVEL OF PLANT POWER PRODUCTION TO RUN THE COMPRESSORS AND PRODUCE ADDITIONAL GAS FOR BLANKET PRODUCTION. IF THE TANKS ARE FILLING FASTER THAN THEY ARE BEING EMPTIED, THE AIR FORCED OUT BY THE INCOMING

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

ALYESKA PIPELINE SERVICE CO.; VALDEZ, ALASKA (CONTINUED)

OIL IS INCINERATED.

THE BOILER PLANT AT THE VALDEZ TERMINAL CONSISTS OF THREE 250 MM BTU/HR OIL-FIRED BOILERS, MANUFACTURED BY COMBUSTION-ENGINEERING. THE OIL BEING USED IN THE BOILERS PRODUCES A VERY LOW PARTICULATE GRAIN LOADING, AND HAS AN EXTREMELY LOW SULFUR CONTENT WHICH RANGES FROM 0.03% TO 0.1%. THERE IS NO PARTICULATE CONTROL OTHER THAN WHAT OCCURS IN THE FMC SO2 ABSORBER MODULE.

THE MAXIMUM DESIGN CAPACITY OF THE SCRUBBER MODULE IS 50,000 SCFM, WHICH REPRESENTS ABOUT 25% OF THE TOTAL FLUE GAS GENERATED. THE SO2 CONTROL SYSTEM IS DESIGNED WITH 100% REDUNDANCY, I.E., THERE ARE TWO MODULES IN PARALLEL, ONLY ONE OF WHICH IS IN USE AT ANYTIME. THE MODULES ARE IDENTICAL 4-STAGE DISH-AND-DONUT TRAY TYPE ABSORBERS WITH A MAXIMUM RECIRCULATION RATE OF 600 GPM AND A L/G RATIO OF 12 GAL/1000 CU FT.

CAUSTIC (SODIUM HYDROXIDE) IS USED AS REAGENT MAKE-UP. DESIGN PH CONTROL WAS ABOUT 6.5, BUT OPERATIONS HAVE INDICATED THAT A HIGHER PH IS MORE DESIRABLE, SO CONTROL PH IS NOW ABOUT 8.0. A BLEED STREAM OF SODIUM BISULFITE/SULFITE GOES TO AN AERATOR AT A RATE OF 10 GPM. AFTER COMPLETE OXIDATION TO NA2SO4, THE WASTE STREAM GOES TO A WASTEWATER TREATMENT AREA WHERE IT IS MIXED WITH 10,000 GPM OF BALLAST WATER FROM THE TANKERS IN THE PORT, AND DISCHARGED INTO THE PORT.

OPERATING HISTORY

3RD QUARTER-1977 CORROSION HAS OCCURRED IN THE PIPING FOR THE WATER RECIRCULATION SYSTEM. AT THE TIME OF THIS REPORT, THE CAUSE WAS NOT KNOWN. ALYESKA TESTS HAVE DEMONSTRATED ABOUT 5 PPM SO2/SO3/SO4 AT THE ABSORBER OUTLET. INLET SO2 CONCENTRATION RANGES FROM 150 TO 160 PPM. THE SYSTEM WAS THEREFORE REMOVING ABOUT 96% OF THE INLET SULFUR OXIDES. AT THE TIME OF THIS REPORT, THERE WAS NO CONTINUOUS SO2 MONITOR ON THE SYSTEM.

4TH QUARTER-1977 THE CONTROL SYSTEM OPERATED NEARLY PROBLEM-FREE, WITH NO DOWNTIME BEING ASSIGNED TO THE SO2 REMOVAL SYSTEM. THE CURRENT LOAD IS APPROXIMATELY 20% OF DESIGN CAPACITY. THIS IS A RESULT OF OIL FLOW BEING LOW AT PRESENT. PLANS WERE BEING MADE TO DEAL WITH THE WET AREAS CORROSION PROBLEM BY INTRODUCING NEUTRALIZING AMINE SPRAYS.

1ST QUARTER-1978 DURING THIS PERIOD, THE CORROSION PROBLEM WAS ALLEVIATED BY SPRAYING HYDRAZINE INTO THE SYSTEM UPSTREAM OF THE MIST ELIMINATOR. THIS MEASURE RAISED FROM 6 TO 6.5 THE PH OF THE LIQUOR RECOVERED BY THE MIST ELIMINATOR. CYCLOHEXAMINE MAY BE TESTED IN PLACE OF THE HYDRAZINE. THE PLANT WAS NOT YET AWARE OF THE CAUSE OF THE CORROSION, ALTHOUGH THEY SUSPECTED CARBON, SULFUR, AND NITROGEN ACID GASES. CHLORIDES HAVE VIRTUALLY BEEN RULED OUT AS THE SOURCE OF THE CORROSION.

2ND QUARTER-1978 THE FMC FGD SYSTEM CONTINUED TO OPERATE ON A CONTINUOUS BASIS, BEING RESPONSIBLE FOR NO DOWNTIME. ANY MAINTENANCE OPERATIONS WERE EFFECTED WHILE THE SYSTEM WAS OPERATING. IT IS IMPORTANT TO NOTE AGAIN THAT THE SYSTEM IS DESIGNED WITH 100% REDUNDANCY.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

ALYESKA PIPELINE SERVICE CO.; VALDEZ, ALASKA (CONTINUED)

3RD QUARTER-1978 THE SYSTEM CONTINUED TO DEMONSTRATE 100% AVAILABILITY DURING THIS PERIOD. CYCLOHEXAMINE IS NOW BEING USED INSTEAD OF HYDRAZINE TO CONTROL PH DOWNSTREAM OF THE ABSORBER. PH IS NOW IN THE 6-7 RANGE AND CORROSION SEEMS TO HAVE STOPPED. IF FURTHER CONTROL OF PH IS NEEDED, ADDITIONAL CYCLOHEXAMINE SPRAY POINTS MAY BE INSTALLED.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	AMERICAN THREAD CO.
INSTALLATION LOCATION	MARION, NORTH CAROLINA
SOURCE CHARACTERISTICS	COAL (1 - 1.5% SULFUR)
SOURCE RATING	18,500 SCFM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	9 MW (EQUIVALENT); TOTAL 2 BOILERS
CONTROL SYSTEM VENDOR	W.W. SLY MANUFACTURING CO.
CONTROL PROCESS	CAUSTIC WASTE STREAM
NEW / RETROFIT	RETROFIT
START-UP DATE	1973
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	70% (500 PPM @ INLET)
PARTICULATE REMOVAL EFFICIENCY	97%
SLUDGE OR BY-PRODUCT DISPOSAL	HOLDING POND FOR EVAPORATION THE SODIUM SULFITE/SULFATE WASTE LIQUOR IS PUMPED TO A RED CLAY LINED ASH BASIN. LEACHING OF THE SOLUBLE SODIUM SALTS IS THEREBY PREVENTED.
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

AMERICAN THREAD COMPANY, LOCATED IN MARION, NORTH CAROLINA OPERATES TWO COAL-FIRED BOILERS, EACH WITH A DESIGN CAPACITY OF 30,000 ACFM @ 400 F. DURING THE WINTER MONTHS ONE BOILER IS OPERATED 7 DAYS/WEEK AT 75% LOAD AND THE OTHER OPERATED 5 DAYS/WEEK ALSO AT 75% LOAD. BOTH BOILERS OPERATE 5 DAYS/WEEK AT 50% LOAD DURING THE SUMMER MONTHS.

THE SCRUBBERS WERE SUPPLIED BY W.W. SLY MANUFACTURING CO. AND WERE ORIGINALLY INSTALLED TO CONTROL PARTICULATE. EACH HAS A DESIGN CAPACITY OF 30,000 ACFM @ 160 F AND IS CONSTRUCTED OF 304 SS AND 316 SS. EACH SCRUBBER IS APPROXIMATELY 10 FEET IN DIAMETER AND 12 FEET HIGH WITH TWO SPRAY LEVELS. THE SCRUBBING LIQUOR IS A 7% CAUSTIC WASTE STREAM FROM A MERCERIZING STEP IN WHICH THREAD IS CLEANED AND SHRUNK. THE CONTROL PH IS 8.5 IN THE RECIRCULATION TANK. SPENT LIQUOR ENTERING THE TANK IS AT A PH OF 2.5. THE SCRUBBERS HAVE BEEN EXHIBITING 90% RELIABILITY.

A 35-40% BLEED STREAM FROM THE RECIRCULATION TANK REMOVES WASTE SOLIDS TO AN ASH POND FOR SETTLING.

REFER TO FIGURE 14-1 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

2ND QUARTER-1978 PLANT REPORTS THAT IT IS STILL EXPERIENCING SCRUBBER I.D. FAN PROBLEMS DUE TO

AMERICAN THREAD CO.; MARION, NORTH CAROLINA (CONTINUED)

VIBRATION AND CORROSION. TO OVERCOME THIS PROBLEM, PLANS ARE BEING MADE TO ELIMINATE THE I.D. FANS ON THE SCRUBBER AND UPGRADE BOILER I.D. FANS.

OTHER PROBLEMS HAVE BEEN AS FOLLOWS:

1. VIBRATION CRACKS IN PVC PIPING.
2. FAILURE OF PUMP RUBBER LINING.
3. THE NEED TO DRAIN THE RECIRCULATION TANK AND PAINT IT WITH EPOXY PAINT TO ALLEVIATE CORROSION PROBLEMS.

3RD QUARTER-1978 THE VIBRATION CRACKS IN THE PVC PIPING ARE LOCATED AT THE ENTRANCE TO THE SCRUBBER AND WERE CAUSED BY AN UNBALANCED FAN. THE FAN BECAME UNBALANCED WHEN ITS FIBERGLASS COATING WAS ERODED AWAY. TWO WEEKS WERE REQUIRED TO PATCH THE COATING. THE CRACKED PIPE SECTIONS WERE REPLACED. PLANS ARE BEING MADE TO REMOVE THE SCRUBBER I.D. FAN COMPLETELY FROM THE SYSTEM AND TO UPGRADE THE EXISTING BOILER I.D. FAN SO THAT IT HAS THE CAPACITY TO OVERCOME THE SCRUBBER SYSTEM PRESSURE DROP.

THE REPLACEMENT OF A PUMP LINING CAUSED THREE DAYS DOWNTIME.

EPOXY PAINT USED ON THE RECIRCULATION TANK WAS INEFFECTIVE. ONE-HALF INCH PLATES WERE WELDED TO THE TANK TO PATCH HOLES CAUSED BY THE CORROSIVE LIQUOR. THE SCRUBBER WAS DOWN FOR A WEEK. CORROSION OF PRESSURE GAUGES AND COPPER LINES HAS ALSO BEEN A PROBLEM AREA.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	ARMCO STEEL
INSTALLATION LOCATION	MIDDLETOWN, OHIO
SOURCE CHARACTERISTICS	COAL (0.8% SULFUR)
SOURCE RATING	84,000 SCFM (TOTAL - 2 BOILERS) 200,000 LB/HR STEAM (TOTAL)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	2
CONTROL SYSTEM VENDOR	KOCH ENGINEERING
CONTROL PROCESS	LIME SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	1975
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	NOT AVAILABLE
SLUDGE OR BY-PRODUCT DISPOSAL	HOLDING POND FOR EVAPORATION
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE SCRUBBER UNIT SERVES TWO MULTI-RETORT, UNDERFEED STOKER, COAL-FIRED BOILERS, EACH WITH A CAPACITY OF 100,000 LBS/HR STEAM. THE COAL BURNED IS TYPICALLY 0.7% TO 0.9% SULFUR AND 8% TO 10% ASH. INITIALLY THE BOILERS WERE OPERATED IN THE WINTER MONTHS ONLY, HOWEVER BEGINNING IN 1976, OPERATIONS WERE YEAR-ROUND WITH REDUCED CAPACITY DURING THE SUMMER.

THE CONTROL SYSTEM CONSISTS OF A VARIABLE-THROAT VENTURI SCRUBBER WITH A PRESSURE DROP-CONTROLLED, ADJUSTABLE PLUG. IMMEDIATELY DOWNSTREAM FROM THE VENTURI IS AN ABSORBER MODULE 17 FEET IN DIAMETER WITH THREE GAS SCRUBBING TRAYS, A S-TYPE CHEVRON MIST ELIMINATOR AND A 106-INCH DIAMETER STUB STACK. THE SYSTEM IS DESIGNED TO HANDLE 140,000 ACFM AT 425 F AND 15 INCHES WG WITH AN OUTLET LOADING OF 0.02 GR PER SCFD. FRESH WATER IS SUPPLIED FROM CLARIFIED RIVER WATER AT THE RATE OF 1600 GPM TO THE TOP TRAY AND VENTURI THROAT. A LIME SLURRY IS ADDED IN A 10,000 GALLON RECYCLE TANK WHICH HOLDS EFFLUENT FROM THE ABSORBER MODULE. THE DESIGN L/G RATIO IS 11.4 GALLONS PER 1000 CFM.

A PH OF APPROXIMATELY 7 IS MAINTAINED IN THE RECYCLE TANK. IF PH VARIES MORE THAN TWO-TENTHS OF A PH UNIT (6.8-7.2), A LIGHT/BUZZER ALERTS THE OPERATORS WHO ADJUST THE PH BY OPENING OR CLOSING A VALVE LEADING FROM THE LIME SLURRY HOLDING TANK TO THE RECYCLE TANK.

THE LARGEST PROBLEM AFFECTING SCRUBBER PERFORMANCE HAS BEEN CONTROL OF EXCESS AIR IN THE BOILERS. WITHOUT CONTROL, EXCESS AIR RESULTS IN 1.5 TO 3 TIMES THE SCRUBBER DESIGN FLOW RATE. THESE HIGH EXCESS AIR RATES ALSO RESULT IN THE PRESENCE OF UNBURNED CARBON WHICH COULD NOT BE SCRUBBED AND COMPOUNDED POOR PERFORMANCE. IN 1977, PROBLEMS OCCURRED WITH THE CHEVRON MIST ELIMINATOR WHICH IS MADE OF NOREL PLASTIC. IT WAS RATED AT 225 F WHICH WAS WELL ABOVE THE TEMPERATURE AT THAT

ARMCO STEEL; MIDDLETOWN, OHIO (CONTINUED)

LOCATION IN THE SYSTEM. HOWEVER, OVERLOOKED WAS THE FACT THAT NOREL IS CREEP SENSITIVE AT 20 DEGREES F ABOVE AMBIENT AND THE CHEVRONS FAILED WITHIN A FEW MONTHS. NEW CHEVRONS OF THE SAME MATERIAL ARE ALSO BEING DAMAGED. STAINLESS STEEL OR FIBERGLASS REINFORCED PLASTIC IS THE PREFERRED MATERIAL FOR THIS APPLICATION.

THE WATER SYSTEM WAS ORIGINALLY DESIGNED TO BE A RECIRCULATING SYSTEM. THE RECIRCULATED WATER HAD A SUSPENDED SOLIDS CONCENTRATION OF 40,000-50,000 MG/L AT THE VENTURI. ALL THE PIPING IN THIS SYSTEM WAS MILD STEEL AND WAS SEVERLY ABRADED CAUSING NUMEROUS LEAKS.

THE SYSTEM HAS BEEN MODIFIED TO A ONCE-THROUGH OPERATION AND THE ABRASION HAS CEASED. SERIOUS ABRASION PROBLEMS WERE ALSO ENCOUNTERED IN 12-INCH STEEL PIPING CARRYING DIRTY WATER FROM THE TRAYS TO THE RECYCLE TANK AS WELL AS IN THE PUMPS. THE PROBLEM WAS SOLVED BY REPLACING THE PIPING WITH RUBBER HOSE, RUBBER LINED ELBOWS, AND RUBBER LINED PUMPS. IN ADDITION, PUMP SPEED WAS REDUCED FROM 1780 TO 1180 RPM AND FLANGED T-SECTIONS WERE INSTALLED ON THE SUCTION SIDE OF THE SLUDGE PUMPS AND RECIRCULATION PUMPS. THIS MATERIAL HAS WITHSTOOD ABRASION BETTER THAN ANY OTHER MATERIAL TRIED TO DATE.

A LIME BUILD UP PROBLEM WAS EXPECTED ON THE ABSORBER TRAYS AT LOW GAS FLOW RATES. THIS PROBLEM HAS NOT YET OCCURRED AT SUSTAINED PH LEVELS OF 6-6.5.

THE LIME SLURRY SYSTEM HAS ALSO PRESENTED A PROBLEM. CLOGGING OF THE LIME SLURRY LINE IS ATTRIBUTED TO ITS EXCESSIVE LENGTH. LIME ADDITION RATE IS A PROBLEM WHICH CAN BE RESOLVED WITH THE INSTALLATION OF A PROPORTIONAL LIME SLAKER.

REFER TO FIGURE 14-2 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

4TH QUARTER-1977 THE PLANT WAS NOT ABLE TO SUPPLY EXTENSIVE UPDATE INFORMATION FOR THIS REPORT PERIOD, ALTHOUGH REPORTED THAT RECENT OPERATIONS HAVE BEEN RELATIVELY PROBLEM-FREE. THE SCRUBBER WAS DOWN IN FEBRUARY 1978 AS A RESULT OF THE POWER SHORTAGE OHIO WAS EXPERIENCING.

2ND QUARTER-1978 NO INFORMATION WAS OBTAINED FOR THIS UPDATE.

3RD QUARTER-1978 ABRASION CONTINUES TO BE A PROBLEM. NEW RUBBER LININGS FABRICATED IN ARMCO'S ON-SITE RUBBER SHOP WILL BE INSTALLED. FIBERGLASS-LINED PIPE WAS ON ORDER.

THE EXCESS AIR PROBLEM HAS BEEN REDUCED TO ABOUT 40% BY PATCHING LEAKS FOUND ON THE BOILER AND REDUCING THE COMBUSTION AIR TO THE BOILER. HOWEVER, DUE TO THE AGE AND CONDITION OF THE BOILER IT IS NOT LIKELY THAT THE EXCESS AIR WILL BE REDUCED FURTHER. THE BOILER IS OPERATED AN ESTIMATED 10 MO/YR. THE SCRUBBER NORMALLY OPERATES APPROXIMATELY 2 TO 3 MONTHS BEFORE IT HAS TO BE SHUT DOWN FOR REPAIRS. THE PLANNED PROPORTIONAL LIME SLAKER WAS NEVER INSTALLED.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	BELRIDGE OIL CO.
INSTALLATION LOCATION	MCKITTRICK, CALIFORNIA
SOURCE CHARACTERISTICS	CRUDE OIL (1.1% SULFUR)
SOURCE RATING	12,000 SCFM
	28,000 ACFM @ 570 F
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	6 MW (EQUIVALENT)
	50 MM BTU/HR
CONTROL SYSTEM VENDOR	THERMOTICS INC.
CONTROL PROCESS	SODIUM HYDROXIDE SCRUBBING
NEW / RETROFIT	NEW
START-UP DATE	JULY, 1978
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	90% (500 PPM SO2 @ INLET)
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	BELRIDGE OIL COMPANY
INSTALLATION LOCATION	MCKITTRICK, CALIFORNIA
SOURCE CHARACTERISTICS	OIL (1.1% SULFUR)
SOURCE RATING	12,000 SCFM (1 BOILER)
	24,000 ACFM @ 570 F
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	1
SOURCE CAPACITY	50 MM BTU/HR
CONTROL SYSTEM VENDOR	HEATER TECHNOLOGY
CONTROL PROCESS	SODIUM HYDROXIDE SCRUBBING
NEW / RETROFIT	NEW
START-UP DATE	JUNE, 1978
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	90% (500 PPM SO2 AT INLET)
WATER MAKE-UP	10 GPM
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

OPERATING HISTORY

3RD QUARTER-1978 SINCE FGD SYSTEM START-UP ON JULY 6, 1978 THE SCRUBBER HAS EXPERIENCED APPROXIMATELY 1 1/2 WEEKS OF DOWNTIME. MAJOR PROBLEMS HAVE BEEN FAULTY RELAYS IN THE INSTRUMENTATION, AND PUMP FAILURE. THE RECIRCULATION PUMP WAS REPLACED.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	CANTON TEXTILES
INSTALLATION LOCATION	CANTON, GEORGIA
SOURCE CHARACTERISTICS	COAL (0.8% SULFUR) INTERRUPTIBLE NATURAL GAS
SOURCE RATING	25,000 SCFM (1 BOILER)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	1
SOURCE CAPACITY	13 MW (EQUIVALENT)
CONTROL SYSTEM VENDOR	FMC ENVIRONMENTAL EQUIPMENT
CONTROL PROCESS	CAUSTIC WASTE STREAM
NEW / RETROFIT	RETROFIT
START-UP DATE	JUNE, 1978
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	70% (500 PPM @ INLET)
PARTICULATE REMOVAL EFFICIENCY	80% - 90% (5.92 LB/MM BTU AT INLET)
WATER MAKE-UP	OPEN LOOP
SLUDGE OR BY-PRODUCT DISPOSAL	NON-FIXATED SLURRY TO LINED POND NA SO3/SO4 LIQUOR DISPOSED TO LINED HOLDING PONDS
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

CANTON TEXTILE MILLS IN CANTON, GEORGIA HAS A 10 MW (EQUIVALENT) STEAM BOILER WHICH FIRES COAL FROM OCTOBER TO MAY AND INTERRUPTIBLE NATURAL GAS THE REMAINDER OF THE YEAR. THE BOILER IS A COM-ENGINEERING (C-E) VERTICAL UNIT EQUIPPED WITH A CYCLONIC DUST COLLECTOR. THE DUST COLLECTOR CAPTURES APPROXIMATELY 75 TO 100 POUNDS OF FLY ASH PER HOUR. THE TYPICAL COAL BURNED HAS A SULFUR CONTENT OF 0.8 PERCENT AND AN AS-RECEIVED HEAT VALUE OF 13,600 BTU PER POUND COAL. SULFUR DIOXIDE CONCENTRATION IN FLUE GAS IS 1500 PPM WITH A PARTICULATE LOADING OF 5.92 LB/MM BTU.

THE FGD SYSTEM CONSISTS OF AN FMC MEDIUM ENERGY, VENTURI-TYPE SCRUBBER. CAUSTIC DYEING WASTEWATER CONTAINING SODIUM HYDROXIDE AND SODIUM SULFATE WITH A PH OF APPROXIMATELY 11 TO 12 IS THE SCRUBBING LIQUOR. THE SCRUBBING LIQUID IS INJECTED INTO THE FLUE GAS STREAM THROUGH SPRAY NOZZLES AHEAD OF THE VENTURI THROAT. THE WASTEWATER IS COLLECTED IN AN EQUALIZATION BASIN. DEPENDING ON THE DESIRED DEGREE OF NEUTRALIZATION, THE WASTEWATER IS THEN RECYCLED TO THE SCRUBBER OR PUMPED TO THE WASTEWATER TREATMENT FACILITY.

SEVERAL OPERATIONAL PROBLEMS WERE ENCOUNTERED UPON INITIAL STARTUP. A SEVERE PLUGGING PROBLEM WAS ENCOUNTERED IN SEVERAL PUMPS DUE TO THE PRESENCE OF COTTON FIBERS IN THE WASTEWATER. A SCREEN BASKET AROUND THE INITIAL SCRUBBER SYSTEM INTAKE PIPE IN THE DYE COLLECTION MANHOLE WAS BEING USED TEMPORARILY UNTIL FURTHER INVESTIGATION IS COMPLETED. SURFACE-ACTIVE AGENTS IN THE DYEING WASTE-

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

CANTON TEXTILES; CANTON, GEORGIA (CONTINUED)

WATERS WHICH PRODUCE FOAMING IN THE SCRUBBER PUMP WERE DETECTED AND A DEFOAMER ADDITIVE IS NOW INJECTED INTO THE SCRUBBER FEED FROM THE DYE RETENTION BASIN. FOULING OF THE PH PROBES AND MIST CARRYOVER ARE OTHER PROBLEM AREAS THAT HAVE BEEN INVESTIGATED.

OPERATING HISTORY

3RD QUARTER-1977 NO OPERATIONAL PROBLEMS WERE REPORTED DURING THIS SURVEY PERIOD. THE PLANT REPORTED THE SYSTEM WAS WORKING SATISFACTORILY. THE PLANT WAS BURNING NATURAL GAS BUT EXPECTED TO RETURN TO COAL DURING THE HEATING SEASON (DECEMBER-MAY).

4TH QUARTER-1977 THE PLANT STARTED BURNING COAL AND OPERATING THE SCRUBBER 100 PERCENT OF THE TIME IN MID-OCTOBER. NO OPERATIONAL PROBLEMS WERE ENCOUNTERED DURING THIS PERIOD.

1ST QUARTER-1978 THE SCRUBBER DEMONSTRATED AN OPERABILITY OF 100%.

2ND QUARTER-1978 THE SCRUBBER WAS SHUTDOWN IN MID-MAY WHEN GAS FIRING RESUMED FOR SUMMER. COAL-FIRING WILL RESUME IN MID-OCTOBER. DURING COAL-FIRED OPERATIONS IN 1977 AND 1978, THE SCRUBBER RAN AT A 100% OPERABILITY.

3RD QUARTER-1978 NO UPDATE INFORMATION WAS AVAILABLE FOR THIS REPORT PERIOD.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	CATERPILLAR TRACTOR CO.
INSTALLATION LOCATION	EAST PEORIA, ILLINOIS
SOURCE CHARACTERISTICS	COAL (3.2% SULFUR)
SOURCE RATING	210,000 SCFM (TOTAL - 4 BOILERS) 80,000 ACFM @ 350 F, FOR EACH OF 4 FGD SYSTEMS
NUMBER OF SEPARATE FGD UNITS	4
NUMBER OF BOILERS BEING CONTROLLED	4
SOURCE CAPACITY	105 MW (EQUIVALENT); TOTAL - 4 BOILERS
CONTROL SYSTEM VENDOR	FMC ENVIRONMENTAL EQUIPMENT
CONTROL PROCESS	DOUBLE ALKALI (CONCENTRATED)
NEW / RETROFIT	2 NEW, 2 RETRO
START-UP DATE	APRIL, 1978
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	90% (2,000 PPM @ INLET)
SLUDGE OR BY-PRODUCT DISPOSAL	DEWATERED SLURRY TO LANDFILL 60+% SOLIDS (CASO4) SLUDGE DIRECTLY TO LANDFILL
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE CATERPILLAR TRACTOR COMPANY PLANT LOCATED IN EAST PEORIA, ILLINOIS HAS FOUR COAL-FIRED BOILERS. TWO OF THE BOILERS ARE RATED AT 200,000 POUNDS OF STEAM PER HOUR AND THE REMAINING TWO ARE RATED AT 210,000 POUNDS OF STEAM PER HOUR. THE COAL BURNED IS ILLINOIS COAL WITH A HEATING VALUE OF 10,500 BTU/LB AND AN AVERAGE SULFUR CONTENT OF 3.2%. THE TOTAL BOILER CAPACITY IS ABOUT 100MW (EQUIVALENT). MECHANICAL COLLECTORS ARE USED FOR PRIMARY PARTICULATE CONTROL.

THE AIR QUALITY CONTROL SYSTEMS HAVE BEEN SUPPLIED BY FMC ENVIRONMENTAL EQUIPMENT DIVISION. THERE IS ONE SCRUBBER TRAIN FOR EACH OF THE FOUR BOILERS, WHICH CONTROLS BOTH PARTICULATE AND SO2 EMISSIONS FROM ABOUT 90,000 ACFM @ 425 F. THE FOUR FGD SYSTEMS SHARE COMMON REGENERATION FACILITIES, VACUUM FILTERS, AND SLUDGE DOSPOSAL.

OPERATING HISTORY

4TH QUARTER-1977 START-UP WAS SCHEDULED FOR MARCH 1978 AND CONSTRUCTION WAS PROGRESSING SMOOTHLY.

1ST QUARTER-1978 CONSTRUCTION OF THE FOUR FGD SYSTEMS WAS COMPLETED. START-UP WAS DELAYED DUE TO THE COAL SHORTAGE.

2ND QUARTER-1978 DURING THIS REPORT PERIOD START-UP OCCURRED. BECAUSE THE BOILER PLANT WAS NEAR THE END OF THE HEATING SEASON, THE BOILER LOADS WERE IN THE 70,000-100,000 LB/HR STEAM RANGE. DURING COLD WEATHER OPERATIONS, THE BOILER LOADS ARE APPROXIMATELY 800,000 LB/HR. THE SYSTEM WAS

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

CATERPILLAR TRACTOR CO.; EAST PEORIA, ILLINOIS (CONTINUED)

BUILDING GOOD FILTER CAKE DURING THE START-UP PHASE OF OPERATIONS. FINAL STEADY STATE OPERATIONS WERE NOT ACHIEVED BEFORE SUMMER SHUTDOWN.

3RD QUARTER-1978 THE FGD SYSTEM HAD JUST STARTED UP AGAIN AFTER SUMMER SHUTDOWN. NO MAJOR START-UP PROBLEMS WERE REPORTED.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	CATERPILLAR TRACTOR CO.
INSTALLATION LOCATION	JOLIET, ILLINOIS
SOURCE CHARACTERISTICS	COAL (3.2% SULFUR)
SOURCE RATING	67,000 SCFM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	34 MW (EQUIVALENT); TOTAL - 2 BOILERS
CONTROL SYSTEM VENDOR	ZURN INDUSTRIES
CONTROL PROCESS	DOUBLE ALKALI (DILUTE)
NEW / RETROFIT	RETROFIT
START-UP DATE	SEPTEMBER, 1974
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	90+% (2000 PPM @ INLET)
PARTICULATE REMOVAL EFFICIENCY	NOT AVAILABLE
WATER MAKE-UP	CLOSED LOOP; 0.5 GPM
SLUDGE OR BY-PRODUCT DISPOSAL	DEWATERED SLURRY TO LANDFILL
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE JOLIET PLANT OPERATES TWO COAL-FIRED BOILERS RATED AT 100,000 AND 80,000 POUNDS OF STEAM PER HOUR. THESE BOILERS ARE ON-LINE ONLY DURING WINTER MONTHS, ONE OF WHICH OPERATES 24 HR/DAY AND THE OTHER ONLY WHEN A GREATER STEAM RATE IS REQUIRED DUE TO COLD WEATHER. THE COAL HAS A HEATING VALUE OF 10,500 BTU/LB AND IS FIRED AT A RATE OF 9.65 TONS/HR. TOTAL SO2 EMISSIONS FROM THE BOLER IS 6.74 LBS/MMBTU.

THE FGD SYSTEM ON EACH BOILER IS A ZURN DOUBLE ALKALI SCRUBBER CONSTRUCTED OF 316L STAINLESS STEEL. EACH SCRUBBER EXHAUSTS THROUGH A CARBON STEEL STACK. THE TOTAL FLUE GAS FLOW RATE IS 103,500 ACFM @ 350 F. THE SCRUBBER UNITS ARE PRECEDED BY MECHANICAL COLLECTORS FOR PARTICULATE REMOVAL.

THE ZURN SCRUBBER UTILIZES A DUSTRAXTOR MODULE FOR BOTH PARTICULATE AND SO2 CONTROL. SPENT SCRUBBING LIQUOR IS PUMPED TO THE REGENERATION AREA WHERE LIME IS ADDED TO PRODUCE CALCIUM SULFITE/SULFATE IN CLARIFIERS. CLARIFIER UNDERFLOW, WHICH IS 15-20% SOLIDS BY WEIGHT, IS DEWATERED BY VACUUM FILTERS TO APPROXIMATELY 65% SOLIDS BY WEIGHT. THE THIXOTROPIC SLUDGE PRODUCED IS READY FOR DISPOSAL AT A LANDFILL. CLARIFIER OVERFLOW IS RETURNED TO THE SCRUBBER AS REGENERATED SCRUBBING LIQUOR. SODA ASH IS ALSO ADDED TO THE REGENERATED LIQUOR TO REPLENISH SODIUM LOST IN THE SLUDGE. LIME AND SODA ASH ARE STORED IN OUTSIDE SILOS AND PNEUMATICALLY CONVEYED TO USE POINTS. A CHEMICAL TREATMENT BUILDING WAS ERECTED TO HOUSE REGENERATION AND SLUDGE HANDLING EQUIPMENT.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

CATERPILLAR TRACTOR CO.; JOLIET, ILLINOIS (CONTINUED)

REFER TO FIGURE 14-3 OF SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

3RD QUARTER-1977 PROBLEMS OCCURRED WHEN A TANK RAN DRY AND DAMAGED A PUMP. SOME PIPE PLUGGING PROBLEMS ALSO OCCURRED AS A RESULT OF THE PUMP FAILURE. A MAJOR PROBLEM AREA WAS THE HEAVY WEAR OF THE FILTER CLOTHS ON THE VACUUM FILTERS. THE FILTER CLOTH LASTS ONLY 2 TO 3 WEEKS. NO SOLUTIONS HAD BEEN FOUND BUT FILTER DESIGN MODIFICATIONS WERE BEING CONSIDERED. THE UNITS WERE ULTRASONICALLY TESTED AND RESULTS SHOW THAT THE SYSTEMS ARE ON THE HIGH SIDE OF TOLERANCE LEVELS. A MINOR LEAK WAS DETECTED AS A RESULT OF A FAULTY WELD.

4TH QUARTER-1977 FGD SYSTEM RESTART OCCURRED AT THE BEGINNING OF THE HEATING SEASON. PLANT HAD INITIATED A PROCESS OF DETAILED RECORD KEEPING BUT WAS STILL WORKING ON THE INTERNAL INFORMATION TRANSFER PROCESS. PLANT HAS INDICATED THAT A SUMMARY OF THESE RECORDS WILL BE AVAILABLE TO THIS REPORT IN THE FUTURE.

1ST QUARTER-1978 FILTER CLOTH PROBLEMS CONTINUED WITH REPLACEMENT BEING REQUIRED EVERY 2-3 WEEKS. THE SYSTEMS WERE DOWN IN MARCH BECAUSE OF PLUGGED PIPELINES.

2ND QUARTER-1978 UNRELIABLE SO2 MONITORS WERE A PROBLEM DURING THIS PERIOD. HEAVY ATTRITION OF FILTER CLOTHS CONTINUED.

3RD QUARTER-1978 DUE TO SHORT FILTER FABRIC LIFE AND SLUDGE FREEZE UP PROBLEMS, FILTER DESIGN MODIFICATIONS WERE STILL BEING CONSIDERED, BUT HAD NOT YET BEEN MADE.

SO2 MONITORS ARE STILL A PROBLEM EXHIBITING PLUGGING, CORROSION, AND UNRELIABLE PERFORMANCE. PROBES OF 304 SS, 316L SS AND TEFLON COATING HAVE ALL BEEN TRIED WITHOUT SUCCESS. HASTELLOY C PROBES HAVE BEEN INSTALLED, BUT THE PLANT HAS NOT HAD TIME TO EVALUATE THEIR PERFORMANCE. REHEAT EQUIPMENT WAS SCHEDULED TO BE INSTALLED BUT HAS NOT BEEN AS OF THIS UP-DATE. GUILLOTINE-TYPE DAMPERS REPLACED THE LOUVER-TYPE ISOLATION DAMPERS ORIGINALLY INSTALLED. HOWEVER, THE GUILLOTINE-TYPE CANNOT BE CLOSED TIGHTLY BECAUSE FLY ASH COLLECTS IN THE BOTTOM OF THE GUILLOTINE SHEATH.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	CATERPILLAR TRACTOR CO.
INSTALLATION LOCATION	MORTON, ILLINOIS
SOURCE CHARACTERISTICS	COAL (3.2% SULFUR)
SOURCE RATING	40,000 SCFM (TOTAL -2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	20 MW (EQUIVALENT); TOTAL 2 BOILERS
CONTROL SYSTEM VENDOR	ZURN INDUSTRIES
CONTROL PROCESS	DOUBLE ALKALI (DILUTE)
NEW / RETROFIT	RETROFIT
START-UP DATE	JANUARY, 1978
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	90% (2000 PPM @ INLET)
SLUDGE OR BY-PRODUCT DISPOSAL	DEWATERED SLURRY TO LANDFILL
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

AT THE MORTON PLANT, A PARTS DISTRIBUTION CENTER, CATERPILLAR TRACTOR OPERATES A TWO-BOILER STEAM PLANT WHICH GENERATES FLUE GAS EQUIVALENT TO ABOUT 20 MW. EMISSIONS ARE CONTROLLED BY A ZURN INDUSTRIES AIR QUALITY CONTROL SYSTEM CONSISTING OF A DUSTRAXTOR SCRUBBER IN WHICH PARTICULATE AND SO2 REMOVAL OCCUR SIMULTANEOUSLY. SULFUR DIOXIDE REMOVAL IS BROUGHT ABOUT BY THE USE OF ZURN DILUTE MODE, DOUBLE ALKALI FGD TECHNOLOGY. THE TWO BOILERS AND THE TWO SCRUBBING TRAINS AND MOST ANCILLARY EQUIPMENT ARE WITHIN THE BOILER HOUSE.

THE SYSTEM AT MORTON IS VERY SIMILAR TO THAT AT THE CATERPILLAR JOLIET PLANT, WHICH HAS BEEN OPERATING EACH HEATING SEASON SINCE OCTOBER 1974. WHENEVER POSSIBLE, PROBLEM AREAS AND SOLUTIONS IDENTIFIED IN JOLIET OPERATIONS HAVE BEEN IMPLEMENTED TO IMPROVE THE SYSTEM DESIGN AT MORTON. SPECIFIC AREAS IN WHICH MODIFICATIONS TO DESIGN HAVE BEEN MADE ARE WATER BALANCE, PUMPS, PH MONITORING, PIPING, LIME STORAGE, AND COLD WEATHER PROTECTION.

OPERATING HISTORY

1ST QUARTER-1978   SYSTEM START-UP OCCURRED AT THE BEGINNING OF JANUARY. INITIAL OPERATIONS WERE PROBLEM-FREE. THROUGH JANUARY AND PART OF FEBRUARY, ZURN PERSONNEL WERE TRAINING THE BOILER PLANT PERSONNEL IN THE OPERATION OF THE FGD SYSTEM. OPERATIONAL EXPERIENCES AT JOLIET AND MOSSVILLE HAVE SHOWN THAT THE BOILER OPERATORS CAN BE EFFECTIVELY TRAINED TO OPERATE AND MAINTAIN THE FGD SYSTEMS. CURRENT PLANS CALLED FOR ACCEPTANCE TESTING IN THE SPRING, BUT THE COAL SITUATION MAY DELAY THE TEST PERIOD.

2ND QUARTER-1978   FGD OPERATIONS CONTINUED TO BE TROUBLE-FREE. THE BOILER WAS EXPERIENCING SOME

CATERPILLAR TRACTOR CO., MORTON, ILLINOIS (CONTINUED)

PUFFING (BACK PRESSURE), THE CAUSE OF WHICH WAS NOT KNOWN.

3RD QUARTER-1978   ACCEPTANCE TESTING WAS DELAYED DUE TO THE PUFFING PROBLEM. THE TESTING WILL BE ATTEMPTED LATE THIS FALL. EVEN THOUGH PUFFING REMAINS A PROBLEM, PLANT PERSONNEL FEEL THEY ARE CLOSER TO RESOLVING IT DUE TO NEW DESIGN MODIFICATIONS TO THE SCRUBBER.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	CATERPILLAR TRACTOR CO.
INSTALLATION LOCATION	MOSSVILLE, ILLINOIS
SOURCE CHARACTERISTICS	COAL (3.2% SULFUR)
SOURCE RATING	140,000 SCFM (TOTAL - 4 BOILERS)
NUMBER OF SEPARATE FGD UNITS	4
NUMBER OF BOILERS BEING CONTROLLED	4
SOURCE CAPACITY	70 MW (EQUIVILENT); TOTAL - 4 BOILERS
CONTROL SYSTEM VENDOR	FMC ENVIRONMENTAL EQUIPMENT
CONTROL PROCESS	DOUBLE ALKALI (CONCENTRATED)
NEW / RETROFIT	1 NEW 1 RETRO
START-UP DATE	OCTOBER, 1975
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	90+% (2000 PPM @ INLET)
SLUDGE OR BY-PRODUCT DISPOSAL	DEWATERED SLURRY TO LANDFILL 60+% SOLIDS (CASO4) SLUDGE DIRECTLY TO LANDFILL
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

AT THE MOSSVILLE PLANT, CATERPILLAR TRACTOR OPERATES A FOUR-BOILER STEAM PLANT. TWO OF THE BOILERS ARE RATED AT 150,000 LBS/HR STEAM AND TWO ARE RATED AT 80,000 LBS/HR STEAM. THE ENTIRE 4-UNIT PLANT IS ROUGHLY EQUIVALENT TO 50 MW OF ELECTRICAL GENERATING POWER. THE COAL FIRED IS HIGH-SULFUR (3.2%-4.0%) ILLINOIS COAL. THE FOURTH BOILER, AT 150,000 LBS/HR, BEGAN OPERATIONS IN JUNE 1977 AND ITS FGD SYSTEM WAS BYPASSED UNTIL OCTOBER 1977.

FMC ENVIRONMENTAL EQUIPMENT DIVISION HAS SUPPLIED AN AIR QUALITY CONTROL SYSTEM CONSISTING OF A VENTURI SCRUBBER FOR PARTICULATE CONTROL AND AN ABSORBER MODULE FOR SO2 CONTROL. FMC CONCENTRATED MODE, DOUBLE ALKALI FGD TECHNOLOGY IS BEING USED IN THE ABSORBER MODULES. THE TWO 150,000 LB/HR BOILERS HAVE MECHANICAL COLLECTORS REMOVING ABOUT 90% OF THE INLET FLYASH. THE SCRUBBING TRAINS ON THE TWO SMALLER BOILERS HAVE NO PRECEDING MECHANICAL COLLECTORS. THE POSITION OF THE VENTURI CAN BE CONTROLLED AUTOMATICALLY BY STEAM FLOW, BUT CURRENTLY IS NOT IN OPERATION.

WHILE THE FLYASH IN THE FINAL FILTER CAKE PROVIDES ADDED MECHANICAL STABILITY, THE HIGH ASH CONTENT IN THE RECIRCULATING SLURRY CAUSED SEVERE EROSION/ABRASION PROBLEMS IN EARLY OPERATIONS. THE ORIGINALLY INSTALLED WEIR TYPE CONTROL VALVES HAVE BEEN REPLACED WITH SPOOL PIECES AND A CONSTANT VOLUME PUMPING SYSTEM. THERE WAS ALSO SIGNIFICANT WEAR IN THE VENTURI SCRUBBER BOTTOMS, WHICH WAS SOLVED BY THE INSTALLATION OF WEAR PLATES.

SEVERAL PROBLEM AREAS WERE IDENTIFIED AND DEALT WITH DURING THE TWO HEATING SEASONS PRIOR TO THE 1977-78 SEASON. THESE ARE LISTED BELOW.

PUMPS - THE RUBBER-LINED SLURRY PUMPS WERE OVERSIZED WHICH CAUSED HIGH PIPE VELOCITIES AND

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

CATERPILLAR TRACTOR CO.; MOSSVILLE, ILLINOIS (CONTINUED)

ACCELERATED WEAR ON THE PUMP LININGS. THESE PUMPS WERE REVISED TO LOWER THEIR OUTPUT. LOW SEAL WATER PRESSURE ALLOWED PROCESS LIQUOR TO GET INTO THE PUMP AND PACKING. ALL SEAL WATER IS NOW ONCE-THROUGH AND SYSTEM PRESSURES HAVE BEEN ADJUSTED TO MAINTAIN SEAL WATER PRESSURE ABOVE PROCESS LIQUID PRESSURES.

SLUDGE HANDLING - SLUDGE IS TRANSPORTED FROM THE VACUUM FILTERS TO THE LOADING AREA ON A BELT CONVEYOR. SEVERAL STRATEGIES, ALL INVOLVING SCRAPING OR PLOWING THE DEWATERED SLUDGE OFF THE BELT, RESULTED IN EXCESSIVE WEAR OF EITHER THE BELTS OR THE PLOWS. THE PRESENT APPROACH SIMPLY DUMPS THE MATERIAL OFF THE END OF THE BELT INTO BINS. THE POSITION OF THE BELT IS CHANGEABLE SO THAT EIGHT BINS CAN BE FILLED BEFORE THEY MUST BE EMPTIED. A FURTHER MODIFICATION HAS A DUAL POSITION CHUTE UNDER EACH BELT END POSITION, SO THAT A TOTAL OF 16 BINS CAN BE WORKED AT A TIME. SLUDGE BINS ARE THEN LOADED HYDRAULICALLY INTO TRUCKS AND HAULED TO THE SANITARY LANDFILL AREA. ANOTHER PROBLEM, COLD WEATHER ICING ON THE SLUDGE LOADING AREA, WAS SOLVED BY ENCLOSING THE AREA.

INSTRUMENTATION - ORIGINAL DESIGN PLANS CALLED FOR CONTROL BY THE MONITORING OF THE SO3/SO4 RATIO AND SODIUM ION CONCENTRATION. THE CONTROL RANGE WAS FOUND TO BE TOO SMALL AND THE PRESENT APPROACH IS PH CONTROL (6.5) AND CLEANING OF THE PROBES EVERY OTHER DAY.

ORIGINAL DESIGN DID NOT MONITOR SO2 CONCENTRATION BUT A COMPLETE MONITOR SYSTEM WAS INSTALLED PRIOR TO THE 1977-78 SEASON.

PIPING - MODIFICATIONS HAVE BEEN MADE WHICH FACILITATE CLEANING OR SCHEDULED REPLACEMENT.

REFER TO FIGURE 14-4 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

4TH QUARTER-1977 CATERPILLAR BEGAN A PROCEDURE OF DETAILED RECORD KEEPING, BUT THE FLOW OF INFORMATION WAS NOT YET SUCH THAT IT WAS AVAILABLE TO THIS REPORT.

2ND QUARTER-1978 NUMEROUS BOILER-RELATED PROBLEMS HAVE COMPOUNDED FGD SYSTEM PROBLEMS. MAJOR FGD PROBLEM AREAS WERE AS FOLLOWS:

EROSION OF SCRUBBER LINER MATERIAL.

EXCESSIVE WEAR OF PIPING, PUMPS, AND CONTROL VALVES.

SLUDGE FREEZE-UP ON THE CONVEYOR BELT PLUGGED SLUDGE CHUTES.

3RD QUARTER-1978 PERFORMANCE OF THE VENTURI SPRAY NOZZLE HAS NOT BEEN SATISFACTORY. NOZZLES OF 316L SS WERE ORIGINALLY INSTALLED AND LASTED ABOUT FOUR MONTHS. CERAMIC NOZZLES WERE THEN TRIED BUT BROKE WHEN BEING REMOVED. THE PLANT RETURNED TO USING 316L SS SINCE THE STEEL NOZZLES WERE CHEAPER THAN THE CERAMIC NOZZLES. PLANS ARE BEING MADE TO MODIFY THE NOZZLE CONFIGURATION. THE VENTURI IS BEING OPERATED MANUALLY SINCE PLANT PERSONNEL HAVE NOT HAD TIME TO DEBUG THE AUTOMATIC CONTROL.

END-DISCHARGING DISH CONVEYORS FOR THE SLUDGE CONVEYOR SYSTEM HAVE NOT YET BEEN INSTALLED BECAUSE THE ENTIRE SLUDGE HANDLING FACILITY IS CURRENTLY BEING REEVALUATED. THIS REEVALUATION IS

CATERPILLAR TRACTOR CO.; MOSSVILLE, ILLINOIS (CONTINUED)

A RESULT OF THE MANY PROBLEMS CATERPILLAR HAS HAD WITH THEIR SLUDGE HANDLING SYSTEM.

MODIFICATIONS TO PIPING IN ORDER TO FACILITATE PIPE CLEANING AND SCHEDULED REPLACEMENTS HAVE NOT BEEN SIGNIFICANT. THE GUILLOTINE DAMPERS AT THIS PLANT ARE EXPERIENCING THE SAME PROBLEMS AS THE DAMPERS AT THE JOLIET PLANT; FLYASH COLLECTING IN THE BOTTOM OF THE DAMPER PREVENTS THE DAMPER FROM BEING CLOSED TIGHTLY. WEAR PLATES WERE INSTALLED IN THE BOTTOM OF THE VENTURI SCRUBBERS TO PREVENT ABRASIVE WEAR AND ARE WORKING WELL. PLANT PERSONNEL FEEL THEY ARE STILL IN A DEBUGGING PHASE.

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	CHEVRON U.S.A. INC.
INSTALLATION LOCATION	BAKERSFIELD, CALIFORNIA
SOURCE CHARACTERISTICS	OIL (1.1% SULFUR)
SOURCE RATING	248,000 SCFM (TOTAL - 18 BOILERS) 150,000 ACFM @ 500F, FOR EACH OF 3 FGD SYSTEMS.
NUMBER OF SEPARATE FGD UNITS	3
NUMBER OF BOILERS BEING CONTROLLED	18
SOURCE CAPACITY	125 MW (EQUIVALENT); TOTAL - 18 BOILERS 900 MM BTU/HR (TOTAL - 18 BOILERS; 6 BOILERS/FGD SYSTEM)
CONTROL SYSTEM VENDOR	KOCH ENGINEERING
CONTROL PROCESS	SODIUM CARBONATE SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	JULY, 1978
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	90% (70 PPM @ OUTLET)
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT AND DISCHARGE TO TAILINGS POND
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

CHEVRON U.S.A. HAS AN OIL SITE AT BAKERSFIELD, CALIFORNIA. THERE ARE ABOUT 50 STEAM GENERATORS WHICH BURN 1.1% SULFUR CRUDE OIL. EACH GENERATOR IS RATED AT 50 MM BTU/HR. THE STEAM IS USED TO HEAT OIL AND FACILITATE ITS FLOW UPWARDS FROM THE OIL WELLS.

KOCH ENGINEERING HAS COMMISSIONED THREE FGD SYSTEMS IN JUNE/JULY 1978. THE SODIUM CARBONATE SCRUBBING PROCESS IS USED, WITH EACH SCRUBBER TREATING FLUE GASES FROM 6 GENERATORS WITH A TOTAL FLOW RATE OF 150,000 ACFM AT 500 F. THERE ARE 3 KOCH FLEXITRAYS AND A KOCH FLEXIMESH MIST ELIMINATOR IN EACH SCRUBBER. THE SPENT LIQUOR IS MIXED WITH FRESH SODIUM CARBONATE IN THE BOTTOM OF THE SCRUBBER. A CONTINUOUS BLEED-OFF STREAM IS TAKEN TO A DISPOSAL POND, WHEREAS THE REST OF THE LIQUOR IS RECIRCULATED. A PH OF 6-6.5 IS MAINTAINED AT THE TOP TRAY AND AN L/G RATIO OF 5 GAL/1000 ACF IS USED. THERE IS NO REHEAT FACILITY BUT THE SCRUBBER CAN BE BYPASSED. THE BOILER I.D. FANS WILL BE UPGRADED TO OFFSET THE PRESSURE DROP OF 9 IN. WG. THE SCRUBBERS ARE DESIGNED TO REMOVE 90% OF THE SO2 AND MAINTAIN AN EXIT SO2 CONCENTRATION BELOW 70 PPM. EACH SCUBBER IS 16.5 FEET IN DIAMETER AND 55 FEET HIGH. THE HEIGHT INCLUDES THAT OF A STUB STACK SITUATED ON TOP OF EACH SCRUBBER.

THE SCRUBBERS AND TRAYS ARE MADE OF 316L SS AND THE FLEXIMESH IS INCOLOY 625. THE STACK IS MADE OF 316 SS AND THE PIPING IS FRP.

3RD QUARTER-1978 BECAUSE OF LOW STEAM DEMAND ONLY TWO OF THE EXISTING THREE SCRUBBERS ARE OPERA-

CHEVRON U.S.A. INC.; BAKERSFIELD, CALIFORNIA (CONTINUED)

TIONAL. OF THE 18 STEAM GENERATORS 12 ARE OPERATIONAL. ONE SCRUBBER CONTROLS 7 GENERATORS WHILE THE OTHER CONTROLS 5 GENERATORS. THE REMAINING 6 STEAM GENERATORS AND THEIR RESPECTIVE SCRUBBERS WILL BE BROUGHT ON-LINE AS STEAM DEMAND INCREASES (POSSIBLY IN DECEMBER OR JANUARY).

NO MAJOR PROBLEMS HAVE OCCURRED SINCE START-UP IN JUNE-JULY. HOWEVER, SOME CLOGGING OF THE SODA ASH FEED CHUTE FROM THE STORAGE SILO DOES OCCUR. THIS CLOGGING IS EASILY CORRECTED WITH NO DOWNTIME NECESSARY.

SYSTEM OPERABILITY FOR THE PERIOD WAS 95%.

GOOD OPERATION IS ATTRIBUTED TO REGULAR MAINTENANCE PRACTICE WITH EMPHASIS ON DAILY CLEANING OF THE PH PROBES.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	FIRESTONE TIRE AND RUBBER CO.
INSTALLATION LOCATION	POTTSTOWN, PENNSYLVANIA
SOURCE CHARACTERISTICS	COAL (2.5 - 3.0% SULFUR)
SOURCE RATING	6070 SCFM (13,000 ACFM @ 300 F)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	1
SOURCE CAPACITY	4 MW (EQUIVALENT)
CONTROL SYSTEM VENDOR	FMC ENVIRONMENTAL EQUIPMENT
CONTROL PROCESS	DOUBLE ALKALI (CONCENTRATED)
NEW / RETROFIT	RETROFIT
START-UP DATE	JANUARY, 1975
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	90.5% (1000 PPM @ INLET)
PARTICULATE REMOVAL EFFICIENCY	97.4% (5 LB/MM BTU @ INLET TO MECHANICAL COLLECTOR.)
SLUDGE OR BY-PRODUCT DISPOSAL	DEWATERED SLURRY TO LANDFILL
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE FIRESTONE TIRE AND RUBBER CO. LOCATED IN POTTSTOWN, PENNSYLVANIA HAS BEEN OPERATING AN FGD SYSTEM SINCE JANUARY 1975 AS A DEMONSTRATION-SIZE PLANT, DESIGNED TO TEST THE FEASIBILITY OF FGD ON INDUSTRIAL BOILERS. THE UNIT IS DEMONSTRATING 90 PERCENT SO2 REMOVAL EFFICIENCY WITH AN AVAILABILITY OF 94 PERCENT AND A FLUE GAS CAPACITY OF 13,000 ACFM OR 3 MW (EQUIVALENT). THIS FLOW REPRESENTS APPROXIMATELY 1/3 OF THE TOTAL OUTPUT OF ONE 120,000 LB/HR STEAM BOILER. THE SULFUR DIOXIDE EMISSION REGULATION FOR THE PLANT IS 0.86 LBS/MILLION BTU OF HEAT OUTPUT.

THE PLANT IS USING THE CONCENTRATED DOUBLE ALKALI PROCESS PATENTED BY FMC CORPORATION. THE LOAD CAPACITY OF THE BOILER ON WHICH THE SCRUBBER IS OPERATING IS APPROXIMATELY 15 MW. IN OCTOBER 1976, THE BOILER WAS CONVERTED FROM BURNING RESIDUAL FUEL OIL (2.2% S) TO COAL (2.5-3.0% S).

THE VENTURI SCRUBBER IS SPRAYED WITH ALKALINE LIQUOR WHERE THE FLUE GAS ENTERS. THE FAN AND DAMPER UPSTREAM OF THE VENTURI CONTROL THE FLUE GAS FEED. SCRUBBING LIQUOR FLOWS FROM THE VENTURI TO THE BOTTOM OF THE CYCLONE DEMISTER AND THEN INTO THE RECIRCULATION TANK. DROPLETS OF SCRUBBING LIQUOR ARE SPUN OUT IN THE CYCLONE AND RUN BACK DOWN INTO THE RECIRCULATION TANK. THE SCRUBBING LIQUOR IS PARTLY RECIRCULATED TO THE VENTURI THUS COMPLETING THE SCRUBBING CYCLE. ACCUMULATION OF SOLUBLE SODIUM BISULFITE IS PREVENTED BY CONTINUOUSLY DRAWING OFF A SMALL STREAM OF SCRUBBER SOLUTION TO THE LIME REACTOR TANK WHERE THE SODIUM SULFITE REACTS WITH LIME TO FORM CALCIUM SULFITE AND SODIUM HYDROXIDE WHICH IS RECYCLED TO THE ABSORBER. CALCIUM SULFITE SLURRY IS TRANSFERRED TO THE ROTARY FILTER. THE FILTER CAKE FORMED (180 LBS/HR, 55% SOLIDS) IS HAULED TO THE LANDFILL. THE WATER BALANCE IS MAINTAINED BY MAKING UP FOR THE LOSSES BY EVAPORATION AND IN THE FILTER CAKE.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

FIRESTONE TIRE AND RUBBER CO. : POTTSTOWN, PENNSYLVANIA (CONTINUED)

THE VENTURI SCRUBBER HAS A VARIABLE THROAT (6 IN. TO 15 IN.) AND IS MADE OF 316L SS. THE OPERATING VELOCITY THROUGH THE VENTURI THROAT IS 200 FT/SEC @ 130 F. THE OPERATING L/G IS 10 GAL/1000 ACF. THE SPRAY NOZZLES ARE ALSO MADE OF 316L SS. THE CYCLONIC DEMISTER (4.75 FT DIA X 7 FT HIGH) OPERATES WITH A PRESSURE DROP OF 2" WG. GAS VELOCITY THROUGH THE DEMISTER IS 100 FT/SEC @ 130 F. THE DEMISTER, RECIRCULATION TANK, AGITATOR, RECIRCULATION PIPING, AND THE FILTER ARE MADE OF 316L SS. THE INLET DUCTWORK, F.D. FAN, THICKENER, AND LIME REACTOR TANK ARE CARBON STEEL. THE RECIRCULATION PUMP IS CAST IRON WITH RUBBER LINING AND THE STACK IS FRP.

REFER TO FIGURE 14-5 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

1ST QUARTER-1975 THE SYSTEM WENT ONSTREAM BURNING 2.2% SULFUR OIL. THE FGD SYSTEM OPERATED 687 HOURS AND WAS CALLED UPON TO OPERATE 819 HOURS, YIELDING A RELIABILITY OF 84.5%. DOWNTIME WAS DUE PRIMARILY TO FAILURES OF COMPONENTS SUCH AS PUMP PACKING.

2ND QUARTER-1975 THE SYSTEM OPERATED 1454 HOURS AND WAS CALLED UPON TO OPERATE 1509 HOURS, YIELDING A RELIABILITY INDEX VALUE OF 96.4%.

3RD QUARTER-1975 SYSTEM OPERATED 1436 HOURS, WAS CALLED UPON TO OPERATE 1503 HOURS, YIELDING A RELIABILITY INDEX VALUE OF 95.5%.

4TH QUARTER-1975 SYSTEM OPERATED 1320 HOURS, WAS REQUIRED TO OPERATE 1493 HOURS, YIELDING A RELIABILITY INDEX VALUE OF 88.4%. LIME FEEDER MALFUNCTIONING AND THICKENER PLUGGING WERE PROBLEMS.

1ST QUARTER-1976 SYSTEM OPERATED 1961 HOURS, WAS CALLED ON TO OPERATE 2035 HOURS, YIELDING A RELIABILITY INDEX VALUE OF 96.4%.

2ND QUARTER-1976 SYSTEM OPERATED 1280 HOURS, WAS CALLED UPON TO OPERATE 1335 HOURS, YIELDING A RELIABILITY INDEX VALUE OF 95.9%.

3RD QUARTER-1976 SYSTEM OPERATED 1157 HOURS, WAS CALLED UPON TO OPERATE 1166 HOURS, THUS DEMONSTRATING ITS HIGHEST RELIABILITY INDEX VALUE, 99.2%.

4TH QUARTER-1976 IN OCTOBER, THE SYSTEM OPERATED AT A RELIABILITY INDEX OF 100%, UNTIL THE UNIT WAS CONVERTED TO COAL FIRING (2.5 - 3.0% SULFUR). THE SYSTEM OPERATED FOR AN ADDITIONAL 511 HOURS, OF THE 526 REQUIRED, DEMONSTRATING A RELIABILITY INDEX VALUE OF 97.2%. IN NOVEMBER AND DECEMBER, THE SYSTEM OPERATED FOR 1172 HOURS AGAINST THE REQUIREMENT OF 1211 HOURS. THEREFORE, THE AVERAGE

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

FIRESTONE TIRE AND RUBBER CO. ; POTTSTOWN, PENNSYLVANIA (CONTINUED)

RELIABILITY INDEX FOR THE TWO MONTHS WAS 96.7%.

1ST QUARTER-1977 SYSTEM OPERATED 1193 HOURS, WAS REQUIRED TO OPERATE FOR 1459 HOURS, YIELDING A RELIABILITY INDEX VALUE OF 81.7%. SYSTEM WAS DESIGNED FOR A MUCH LOWER PARTICULATE LOADING THAN THAT ACTUALLY ENCOUNTERED ON COAL FIRING. THE HIGH GRAIN LOADING CAUSED ABNORMAL WEAR AND DOWNTIME OF THE F.D. FAN.

2ND QUARTER-1977 SYSTEM OPERATED 1398 HOURS, WAS REQUIRED TO OPERATE 1690 HOURS, YIELDING A RELIABILITY INDEX VALUE OF 82.7%. THE MAJOR CAUSES OF DOWNTIME WERE F.D. FAN EROSION AND PUMP COMPONENT FAILURES.

3RD QUARTER-1977 SYSTEM OPERATED 1131 HOURS, WAS REQUIRED TO OPERATE 1197 HOURS, YIELDING A RELIABILITY FIGURE OF 94.5%. THE TOTAL REQUIRED HOURS WERE LOW IN JULY DUE TO BOILER HOUSE SHUTDOWN AND SUBSEQUENT START-UP.

4TH QUARTER-1977 IN OCTOBER, THE SYSTEM OPERATED 432 HOURS OUT OF THE 511 REQUIRED AS THE BOILER WAS FIRING COAL. THE RELIABILITY VALUE WAS THEREFORE 84.6%. DOWNTIME WAS CAUSED BY PROBLEMS WITH THE LIME CONVEYOR. WHEN OIL WAS BEING FIRED THE SYSTEM OPERATED 95 OF THE 102 HOURS REQUIRED, DEMONSTRATING A RELIABILITY VALUE OF 92.6%. IN NOVEMBER AND DECEMBER, THE SYSTEM OPERATED 792 HOURS OF THE REQUIRED 854, WHILE BURNING COAL, YIELDING A RELIABILITY OF 86.7%. DOWNTIME WAS CAUSED BY FAN PROBLEMS AND LIME FEEDER PROBLEMS.

1ST QUARTER-1978 THE SPRAY NOZZLES, ORIGINALLY 316 STAINLESS STEEL, WERE REPLACED BY 316L SS. THE SPRAY BARS WERE METALLIZED WITH 316 SS.

2ND QUARTER-1978 THE FAN WAS REPLACED BY A NEW FAN CONSTRUCTED OF AN ABRASION RESISTANT CARBON STEEL. THE FAN HOUSING WAS METALLIZED WITH 316 SS. LEAKS IN THE VENTURI SECTION AND DOWNSTREAM DUCTWORK WERE REPAIRED. THE FGD SYSTEM EXHIBITED AN AVAILABILITY OF 89.5% FOR THIS REPORT PERIOD.

3RD QUARTER-1978 NO UNUSUSAL PROBLEMS WERE ENCOUNTERED DURING THIS PERIOD. DOWNTIME WAS DUE TO NORMAL MAINTENANCE. PRELIMINARY ENGINEERING FOR THE FULL SCALE-UP SYSTEM IS COMPLETE. FINAL DESIGN WILL BE DELAYED UNTIL THE ENERGY BILL CURRENTLY BEFORE CONGRESS IS FINALIZED. PLANT PERSONNEL ATTRIBUTE THEIR SUCCESSFUL OPERATION OF THE FGD SYSTEM TO A GOOD UNDERSTANDING AND IN-DEPTH KNOWLEDGE OF PROCESSES AND CONTROLS.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	FMC (SODA ASH PLANT)
INSTALLATION LOCATION	GREEN RIVER, WYOMING
SOURCE CHARACTERISTICS	COAL (1% SULFUR)
SOURCE RATING	646,000 SCFM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	223 MW (EQUIVALENT); TOTAL - 2 BOILERS
CONTROL SYSTEM VENDOR	FMC ENVIRONMENTAL EQUIPMENT
CONTROL PROCESS	SODIUM CARBONATE SCRUBBING
NEW / RETROFIT	NEW
START-UP DATE	MAY, 1976
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	95% (800 PPM AT INLET)
PARTICULATE REMOVAL EFFICIENCY	REMOVED BY PRECEDING ESP (99.5%)
WATER MAKE-UP	OPEN LOOP; L/G = 15-20 GAL/1000 ACF
SLUDGE OR BY-PRODUCT DISPOSAL	HOLDING POND FOR EVAPORATION NA2SO3/SO4 LIQUOR DISPOSED TO COLLECTION POND - NO PRIOR AERATION. LANDFILL IN THE FUTURE
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

FMC CHEMICAL CORP. HAS A SODA ASH PLANT IN GREEN RIVER, WYOMING. THE PLANT HAS TWO COAL-FIRED POWER BOILERS WHICH BURN 1.1 PERCENT SULFUR COAL. THE FLUE GAS FROM EACH BOILER (330,000 ACFM AT 320 F) IS TREATED BY A HOTSIDE ESP WITH 288 PLATES AND A PARTICULATE REMOVAL EFFICIENCY OF 99.5 %.

THE FLUE GASES ARE SCRUBBED BY THE PLANT END-LIQUOR IN TWO SCRUBBERS, EACH WITH THREE PAIRS OF DISC-AND-DONUT TRAYS. THE SCRUBBERS AND THE DISCS ARE LINED WITH CEILCOTE 103 WHEREAS THE DONUT PARTS OF THE TRAYS ARE MADE FROM INCONEL 825. THE SCRUBBER LIQUOR IS MAINTAINED AT A PH OF 6.5 AND IS RECIRCULATED AT A RATE OF 10 - 15 GALLONS/1000 ACF OF FLUE GAS. A PART OF THE RECIRCULATING LIQUOR IS CONTINUOUSLY PURGED TO REMOVE SULFITES AND SULFATES FORMED BY THE REACTION OF SO2 WITH SODA ASH. THE RECIRCULATING PUMPS AND THE RELATED PIPING IS RUBBER LINED. A MESH TYPE DEMISTER IS USED IN EACH SCRUBBER. THE GASES ARE REHEATED BY DIRECT FIRING OF NATURAL GAS AT THE EXIT OF THE SCRUBBERS. THE REHEATED FLUE GAS IS MIXED WITH BYPASSED GAS BEFORE GOING TO THE STACK AT ABOUT 180 F. DAMPERS WITH REMOTE CONTROLS REGULATE THE FLOW OF OFF GAS THROUGH AND AROUND THE SCRUBBERS. APPROXIMATELY 50% OF THE TOTAL FLUE GAS IS RUN THROUGH THE SCRUBBERS.

AUTOMATIC CONTROLS MAINTAIN SOLUTION LEVEL IN THE SCRUBBER BASIN. THE PRIMARY SOURCE OF WATER MAKE-UP IS PROCESS WASTEWATER WHICH IS CHANNELED TO A MAKE-UP TANK. IF MORE MAKE-UP IS REQUIRED, RIVER WATER IS TAPPED. THE SCRUBBER BLEED STREAM IS DISCHARGED TO A WASTE POND AT THE SITE.

FMC (SODA ASH PLANT); GREEN RIVER, WYOMING (CONTINUED)

OPERATING HISTORY

3RD QUARTER-1977 SOME PROBLEMS OCCURRED WITH THE SCRUBBER LINING AS A RESULT OF FAULTY INSTALLATION. THE POSSIBILITY OF RUNNING THE SYSTEM WITH NO REHEAT WAS BEING INVESTIGATED.

4TH QUARTER-1977 THE SCRUBBERS CORRODED AS A RESULT OF FAULTY INSTALLATION OF THE LINING. THE IMPURITIES IN THE SCRUBBING LIQUOR CAUSE FOAMING AND SEDIMENTATION ON THE TRAYS.

1ST QUARTER-1978 PIPELINE FREEZUPS, AND LEAKS FROM THE VANE DAMPERS WERE THE MAIN PROBLEM AREAS.

2ND QUARTER-1978 THE DEMISTER WAS PLUGGED, AND THE RECIRCULATION PUMP WAS DOWN FOR SOME PERIOD. PH CONTROL IS NOT VERY EFFECTIVE, CAUSING PH EXCURSIONS TO ABOUT 3.0. THIS HAS CAUSED SCALING IN THE PIPELINES AND IN THE TOWER. FMC TESTS HAVE MEASURED SO2 REMOVAL EFFICIENCY IN THE RANGE OF 87%-94%, DEPENDING ON L/G AND PH.

3RD QUARTER-1978 TWO ANNUAL SCHEDULED OUTAGES OCCURRED DURING THIS PERIOD. ONE LASTED 2 WEEKS IN AUGUST WHILE THE OTHER LASTED 1 WEEK IN SEPTEMBER. MAINTENANCE ON THE FGD SYSTEM DURING THESE OUTAGES INCLUDED CLEANING OF THE SYSTEM AND FREEING OF THE DAMPER. THE DAMPERS HAD A PROBLEM OPERATING PROPERLY DURING COLD WEATHER. IT WAS DETERMINED THAT THE PUMP OUTAGE DURING THE 2ND QUARTER WAS CAUSED BY A BROKEN SHAFT. THE SHAFT WAS REPLACED.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	GENERAL MOTORS CORPORATION
INSTALLATION LOCATION	DAYTON, OHIO
SOURCE CHARACTERISTICS	COAL(0.7% - 2.0% SULFUR)
SOURCE RATING	56,000 SCFM (TOTAL - 2 BOILERS) 34,000 ACFM @ 500F, FOR EACH OF TWO BOILERS. 120,000 LB/HR STEAM (TOTAL)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	8 MW (EQUIVALENT); TOTAL - 2 BOILERS
CONTROL SYSTEM VENDOR	ENTOLETER, INC.
CONTROL PROCESS	SODIUM HYDROXIDE SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	SEPTEMBER, 1974
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	86% (1.43 LB/MM BTU @ INLET)
PARTICULATE REMOVAL EFFICIENCY	97.5% (0.107 LB/MM BTU @ OUTLET)
WATER MAKE-UP	50 GPM
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT AND DISCHARGE TO CITY SEWER NA2SO3/SO4 LIQUOR AT 35 GPM TO ON-SITE CLARIFICATION AND DEWATERING FACILITY
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

IN DAYTON, OHIO, GENERAL MOTORS OPERATES A FACTORY WHICH MANUFACTURES BRAKES AND OTHER PARTS FOR THEIR AUTOMOBILES. THE PLANT HAS TWO STOKER-FEED, COAL-FIRED BOILERS WHICH WERE INSTALLED IN 1954 BY BABCOCK AND WILCOX. EACH BOILER IS RATED AT 60,000 LB/HR STEAM, AND BURNS A MAXIMUM OF 3 TONS OF COAL PER HOUR. THE BOILERS ARE EQUIPPED WITH INTERNAL MULTICLONES FOR PRIMARY PARTICULATE CONTROL. THE STEAM GENERATED BY THESE BOILERS IS USED FOR BUILDING HEAT AND PROCESS NEEDS. ONE BOILER IS OPERATED CONTINUOUSLY THROUGHOUT THE YEAR AND THE OTHER IS OPERATED APPROXIMATELY 6 MONTHS PER YEAR. THE MAJORITY OF THE TIME (8 - 10 MONTHS/YR) ONLY ONE BOILER IS IN SERVICE.

THE EMISSION CONTROL SYSTEM WAS DESIGNED TO CONTROL BOTH FLYASH AND SO2, AND WAS SUPPLIED AS A RETROFIT APPLICATION BY ENTOLETER, INC. IN SEPTEMBER 1974. EACH BOILER IS FOLLOWED BY A BOILER I.D. FAN, A PLENUM, AND A SCRUBBER F.D. FAN. THE PLENUM CAN FUNCTION IN ONE OF THREE WAYS: IT CAN FEED FLUE GASES TO THE SCRUBBER MODULE; IT CAN BYPASS THE GASES TO THE ATMOSPHERE IN CASE OF A SCRUBBER MALFUNCTION; OR IT CAN MIX AMBIENT AIR WITH THE FLUE GASES IN CASE OF LOW LOAD IN ORDER TO MAINTAIN CONSTANT AIR FLOW TO THE SCRUBBER FAN.

THE SCRUBBER CONSISTS OF THE ENTOLETER "VANE-CAGE" (5 FT. DIA. X 8 FT. HIGH) WHICH IS HOUSED IN

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

GENERAL MOTORS CORPORATION; DAYTON, OHIO (CONTINUED)

A CONICAL BOTTOM SECTION (8 FT. DIA. X 5 FT. HIGH), AN INTERMEDIATE SECTION (6 FT. DIA. X 5 FT. HIGH), AND A DISENGAGEMENT ZONE (10 FT. DIA. X 12 FT. HIGH). THE FLUF GAS (34,000 ACFM @ 500F) ENTERS THE BOTTOM SECTION TANGENTIALLY. RECIRCULATING LIQUOR IS SPRAYED FROM THE TOP OF THE VANE CAGE SECTION, WHICH CAN BE MOVED VERTICALLY TO VARY THE PRESSURE DROP ACROSS THE SCRUBBER. A PRIMARY DEMISTER IS LOCATED ABOVE THE PREVIOUSLY MENTIONED INTERMEDIATE SECTION AND A SECONDARY DEMISTER IS LOCATED ATOP THE DISENGAGEMENT ZONE. THE GAS THEN PASSES THROUGH A STUB STACK TO THE ATMOSPHERE. SCRUBBING LIQUOR IMPINGES ON THE BOTTOM OF THE VANE CAGE AND A SPRAY CHAMBER EFFECT PROVIDES THE SO2 REMOVAL. SCRUBBER UNDERFLOW, CONTAINING PARTICULATE AND A NA2SO3/SO4 SOLUTION IS SENT TO THE RECYCLE TANK, WHERE MAKEUP WATER AT A RATE OF 50 GPM IS ADDED. RECYCLE PUMPS TAKE LIQUOR FROM THE RECYCLE TANK TOP, ALONG WITH THE CAUSTIC STREAM ADDED AT A RATE OF 14 GALLONS PER HOUR TO THE FEED LINE, AND RECIRCULATE IT TO THE TOP OF THE VANE CAGE AT A RATE OF 200 GPM. THE L/G RATIO IS 6 GAL/1000 ACF, AND A TYPICAL PRESSURE DROP ACROSS THE SCRUBBER IS 7 IN. WG. A BLEED OFF FROM THE RECIRCULATION LINE (50 GPM) IS PURGED TO A WASTEWATER TREATMENT FACILITY, WHICH CLARIFIES ALL THE PLANT WASTE STREAMS, ADJUSTS THE PH (7-9), AND DISCHARGES TO CITY SEWERS.

ABSORBER MODULES, DEMISTERS, STACKS, AND THE RECYCLE TANK ARE CONSTRUCTED OF 316L STAINLESS STEEL. THE SCRUBBER F.D. FANS, PLENUMS, CAUSTIC TANK, CAUSTIC PUMP, AND INLET DUCTWORK ARE ALL CARBON STEEL. THE RECIRCULATION PUMPS AND PIPING ARE RUBBER-LINED.

THE TOTAL INSTALLED COST OF THE SYSTEM WAS $668,000 IN 1974 DOLLARS. THE AVERAGE OUTLET SO2 CONCENTRATION IS 0.21 LB/MM BTU, WELL UNDER THE REGULATION OF 1.0 LB/MM BTU. THE OUTLET PARTICULATE LOADING IS 0.107 LB/MM BTU AND THE REGULATION IS 0.177 LB/MM BTU.

REFER TO FIGURE 14-6 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

4TH QUARTER-1974 UPON START-UP, SEVERAL PROBLEMS WERE ENCOUNTERED. PARTICULATE BUILDUP CAUSED PLUGGING OF THE RECYCLE TANK DRAIN AND WASTE STREAM SUMP PUMPS. AIR PURGE STREAMS WERE INSTALLED TO ALLEVIATE THESE PROBLEMS.

1ST QUARTER-1975 THE DAMPERS AND DAMPER CONTROL SYSTEMS WERE MAJOR PROBLEMS. THREE SETS OF EXPANSION JOINTS HAD TO BE INSTALLED BEFORE ACHIEVING PROPER FLOW CONTROL.

2ND QUARTER-1975 A FAN BEARING HAD TO BE REPLACED THREE TIMES.

3RD QUARTER-1975 INSTRUMENTATION AND CONTROL PROBLEMS PROMPTED WIRING REVISIONS.

4TH QUARTER-1976 THE FGD SYSTEM DEMONSTRATED AN AVAILABILITY OF 93 PERCENT.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

GENERAL MOTORS CORPORATION; DAYTON, OHIO (CONTINUED)

1ST QUARTER-1977 THERE WERE MECHANICAL PROBLEMS WITH THE VANE CAGE DRIVE. THE ACCESS DOOR DEVELOPED LEAKS AND THE LIQUOR CORRODED THE OUTER SURFACE OF THE INLET DUCT AROUND THE ACCESS DOOR.

4TH QUARTER-1977 CORROSION AND PLUGGING PROBLEMS CONTINUED TO HAMPER SCRUBBER OPERATIONS. HOWEVER, USUALLY WHEN A SCRUBBER IS DOWN, THE OTHER BOILER IS FIRED UP WHILE REPAIRS ARE MADE TO THE DOWNED UNIT.

1ST QUARTER-1978 THE PRIMARY DEMISTER WAS SEVERELY CORRODED DUE TO ACID DROPPING DOWN ONTO IT FROM THE UPPER DEMISTER.

2ND QUARTER-1978 THE FOLLOWING SYSTEM MODIFICATIONS WERE BEING PLANNED: THE INTERMEDIATE SECTION WILL BE REMOVED. THE PRIMARY DEMISTER WILL BE REPLACED BY A SIMILAR VANE-TYPE HASTELLOY-G DEMISTER, THE SECONDARY DEMISTER WILL BE REPLACED BY A RADIAL VANE HASTELLOY-G DEMISTER, AND A CONVEX IMPINGEMENT BAFFLE PLATE OF HASTELLOY-G WILL BE INSTALLED ABOVE THE PRIMARY DEMISTER TO ASSIST IN RAPID DRAINAGE OF THE ACID DROPLETS.

3RD QUARTER-1978 THE MODIFICATIONS DESCRIBED IN THE 2ND QUARTER 1978 ARE STILL IN THE DESIGN PROCESS. WORK INCORPORATING THE MODIFICATIONS SHOULD BEGIN ABOUT THE END OF OCTOBER.

THE SCRUBBER LINING OF COAL TAR EPOXY WAS ABRADED OFF AND A CARBOLENE LINER WAS INSTALLED. THIS LINING HAS BEEN FLAKING OFF IN PLACES AS A RESULT OF IMPROPER APPLICATION.

THE PH PROBES AND PH MONITORING SYSTEM ARE BEING REDESIGNED SINCE THE SYSTEM CURRENTLY IN USE SEEMS TO BE CONTINUALLY OUT OF CALIBRATION. AN ULTRASONIC CLEANER WAS INSTALLED BUT IS NOT WORKING WELL. THE PH MONITORING SYSTEM IS A DUAL PROBE SYSTEM WHICH ALLOWS A PROBE TO BE IN USE WHILE THE OTHER IS CLEANED.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	GENERAL MOTORS CORPORATION
INSTALLATION LOCATION	PARMA, OHIO
SOURCE CHARACTERISTICS	COAL (2.5% SULFUR)
SOURCE RATING	128,400 SCFM (TOTAL - 4 BOILERS) 320,000 LB/HR STEAM (TOTAL)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	4
SOURCE CAPACITY	64 MW (EQUIVALENT); TOTAL - 4 BOILERS
CONTROL SYSTEM VENDOR	GM ENVIRONMENTAL
CONTROL PROCESS	DOUBLE ALKALI (DILUTE)
NEW / RETROFIT	RETROFIT
START-UP DATE	MARCH, 1974
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	90% (800-1300 PPM @ INLET)
PARTICULATE REMOVAL EFFICIENCY	83% (AT INLET: UNITS 1&2 - 1.75 LB/MIN; UNITS 3&4 - 1.22 LB/MIN)
WATER MAKE-UP	CLOSED LOOP
SLUDGE OR BY-PRODUCT DISPOSAL	DEWATERED SLURRY TO LANDFILL 50+% SOLIDS (CASO3/SO4) SLUDGE TO DRYING POND AND LANDFILL
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE CHEVROLET PARMA PLANT OF GENERAL MOTORS IS LOCATED NEAR CLEVELAND, OHIO. THE PLANT HAS FOUR SPREADER-STOKER BOILERS FIRED BY TRAVELING GRATES, CAPABLE OF PRODUCING A TOTAL OF 320,000 LB/HR OF STEAM OR APPROXIMATELY 32 MW OF EQUIVALENT ELECTRICAL CAPACITY. THE COAL FIRED IN THESE UNITS ORIGINATES PRIMARILY FROM THE SOUTHEASTERN PORTION OF OHIO AND HAS THE FOLLOWING AVERAGE CHARACTERISTICS: HEAT CONTENT OF 11,300 BTU/LB, SULFUR CONTENT OF 1.7 TO 2.7 PERCENT, ASH CONTENT OF 6.8 TO 14.8 PERCENT, AND A TOTAL MOISTURE CONTENT OF 7.6 PERCENT.

THE POWER BOILERS HAVE AN EMISSION CONTROL SYSTEM CONSISTING OF MECHANICAL COLLECTORS UPSTREAM OF A DILUTE DOUBLE ALKALI SCRUBBING SYSTEM. THE FGD SYSTEM SCRUBBING MODULES WERE SUPPLIED BY KOCH ENGINEERING. INSTALLATION WAS COMPLETED ON FEBRUARY 28, 1974. THE SYSTEM CONSISTS OF FOUR SCRUBBERS OPERATING IN PARALLEL. EACH SCRUBBER CONTAINS THREE BUBBLE-CAP ABSORPTION TRAYS AND A MESH MIST ELIMINATOR. THE FLUE GAS RATE IS 61,500 ACFM AT 393 F FOR EACH OF THE FIRST TWO SCRUBBERS AND THE OUTLET TEMPERATURE IS 137 F. THE INLET SO2 CONCENTRATION IS 765 PPM. THE FLUE GAS FLOW RATE IS 58,600 ACFM AT 550 F FOR THE OTHER TWO SCRUBBERS AND THE OUTLET TEMPERATURE IS 152 F. THE INLET SO2 CONCENTRATION IS 800-1300 PPM. OUTLET CONCENTRATION VARIES FROM 130-220 PPM FOR THE SCRUBBERS.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

GENERAL MOTORS CORPORATION; PARMA, OHIO (CONTINUED)

THE SULFUR DIOXIDE CONTAINED IN THE BOILER FLUE GAS IS ABSORBED BY A REGENERATED CAUSTIC SOLUTION (0.1 MOLAR NAOH), FORMING A SOLUTION OF SOLUBLE SODIUM SALTS. THE SPENT CAUSTIC IS THEN REGENERATED BY REACTING THE SODIUM SALT SOLUTION WITH SLAKED LIME, RESULTING IN THE FORMATION OF CALCIUM SULFITE/SULFATE SOLIDS, WHICH ARE SEPARATED OUT OF THE SOLUTION. NEXT, SODA ASH IS ADDED TO THE SOLUTION IN ORDER TO MAKE UP FOR SODIUM LOSSES AND MINIMIZE THE SCALE POTENTIAL FROM THE CALCIUM WHICH REMAINS IN SOLUTION. THE REGENERATED CAUSTIC FORMED IS THEN RECYCLED BACK TO THE SCRUBBER FOR ADDITIONAL SULFUR DIOXIDE REMOVAL. THE CALCIUM SALT AND FLY ASH SLUDGE WHICH RESULTS IS DEWATERED AND HAULED AWAY BY TRUCK TO AN OFF-SITE LANDFILL.

EQUIPMENT SPECIFICATIONS

SCRUBBERS. EACH OF THE 4 SCRUBBERS IS 10.5 FT DIA X 22.5 FT HIGH X 11 GAUGE THICK AND CONTAINS 3 BUBBLE-CAP TRAYS. ALL THE SCRUBBERS AND TRAYS ARE MADE OF 316L SS. THE SCRUBBERS HAVE A TURNDOWN RATIO OF 3 AND ALSO HAVE A BYPASS DUCT. THE DESIGN L/G RATIO IS 20 GALLONS/ACF BUT THIS MAY BE VARIED DURING OPERATION. THE PRESSURE DROP ACROSS THE SCRUBBER RANGES BETWEEN 8-9 IN. WG.

DEMISTERS. ORIGINAL 316 SS MIST ELIMINATORS WERE CORRODED DUE TO CONDENSATION AND WERE REPLACED BY FLEXIMESH-TYPE POLYPROPYLENE MIST ELIMINATORS.

RECYCLE TANKS/PUMPS. ALL THE 4 RECYCLE TANKS ARE MILD STEEL WITH TAR TYPE RESIN COATING. THE PUMPS (6 TOTAL, 2 SPARE) ARE CENTRIFUGALS WITH MILD STEEL CASING AND HAVE RUBBER LININGS. THE PUMP MOTORS ARE 40 HP.

CHEMICAL MIX TANKS & AGITATORS. BOTH THE MIX TANKS ARE MILD STEEL WITH 5000 GALLONS CAPACITY. THE DESIGN RESIDENCE TIME IS 7 MINUTES. NEW AGITATORS ARE PROPELLER TYPE. THESE ARE SPECIALLY DESIGNED TO GIVE HIGHER FLOW RATE THROUGH THE BLADES. THE DRIVE RATINGS ARE 5 HP AND 45 RPM.

CLARIFIERS. BOTH THE CLARIFIERS (60 FT DIA X 14 FT LIQUID DEPTH) HAVE A CONICAL BOTTOM AND 300,000 GALLONS CAPACITY. THE DESIGN RETENTION TIME IS ABOUT 4 HOURS AT A FLOW RATE OF 1200 GPM.

VACUUM FILTERS. BOTH THE VACUUM FILTERS HAVE 500 SQ. FT. OF SURFACE AREA WITH A 10 FT DRUM DIAMETER. THE DRUM DRIVE SPEED IS 0.5 RPM MAXIMUM.

FILTRATE TANK/PUMPS. THE TANK (4 FT DIA X 7 FT HIGH) IS MILD STEEL AND HOLDS 660 GALLONS OF FILTRATE. THE PUMPS ARE MILD STEEL, CENTRIFUGAL AND HAVE A CAPACITY OF 300 GPM AT 15 FT. OF HEAD.

EARLY PROBLEMS AND SOLUTIONS

THE SYSTEM WAS STARTED UP ON FEBRUARY 28, 1976 AND BY APRIL 31, IT HAD OPERATED FOR 264 HOURS. THERE WERE TWO SCHEDULED SHUTDOWNS DURING THIS PERIOD FOR EQUIPMENT INSPECTION. THE SECOND SHUTDOWN REVEALED THAT SOLIDS WERE NOT BEING DISCHARGED FROM THE PRIMARY CLARIFIER RAPIDLY ENOUGH.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

GENERAL MOTORS CORPORATION; PARMA, OHIO (CONTINUED)

AS A RESULT, THE CLARIFIER RAKE JAMMED. A PIPING CHANGE WAS MADE TO BLEND THE CAUSTIC FEED IN WITH THE RECYCLE LIQUOR. THIS IMPROVED PERFORMANCE BUT DID NOT COMPLETELY ELIMINATE THE PROBLEM. PREMATURE CAKE CRACKING IN THE VACUUM FILTERS REQUIRED THE PRESENCE OF AN OPERATOR DURING OPERATION. CAKE WASHING TO REDUCE LOSSES WAS NOT INITIALLY SUCCESSFUL BECAUSE THE SPRAY WATER TENDED TO KNOCK THE CAKE OFF THE DRUM. ALTERATIONS IN SPRAY PATTERN AND OTHER MEASURES APPARENTLY SOLVED THIS PROBLEM. THERE WAS NO EVIDENCE OF CORROSION OR ABRASION IN THE PUMPS OR PIPING.

THE SYSTEM WAS SHUT DOWN FROM MAY 1 TO MAY 28, 1974, BECAUSE OF UNEXPECTED BUILDUP OF SOLIDS IN THE CLARIFIER, WITH SUBSEQUENT OVERFLOW INTO THE SCRUBBER. THE PROBLEM WAS SOLVED BY 1) USING A POLYMERIC FLOCCULATION AGENT TO ATTAIN BETTER SETTLING AND 2) WITHDRAWING SLUDGE FROM THE CLARIFIER AT MORE FREQUENT INTERVALS. SYSTEM AVAILABILITY TO THE BOILER WAS 87 PERCENT IN APRIL 1974, LESS THAN 10 PERCENT IN MAY, AND 100 PERCENT IN JUNE, JULY, AND AUGUST AFTER THE SYSTEM WAS RESTARTED. PLUGGING BY GYPSUM DEPOSITS IN THE OVERFLOW LINE BETWEEN THE CLARIFIERS AND IN THE LINE FROM CLARIFIER NO. 2 TO THE MIX TANKS WAS CORRECTED BY RELOCATING A CHEMICAL FEED LINE AND REPLACING SOME PIPING. THE SYSTEM WAS DOWN THROUGH JULY AND AUG. 1975 FOR REPLACEMENT OF GRAVITY FLOW LINES WITH AN OPEN FLUME THAT CAN BE EASILY CLEANED. THE OPERABILITY INDEX FOR THE FGD SYSTEM INCREASED SIGNIFICANTLY THROUGHOUT THE COURSE OF 1976.

REFER TO FIGURE 14-7 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

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        OPERATION HOURS
MONTH   BOILER  FGD SYSTEM  OPERABILITY (%)
MAY-JUN. 75
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THE SYSTEM WAS RESTARTED AND PARTICULATE TESTS WERE CONDUCTED IN MAY. THE SYSTEM WAS SHUT DOWN DUE TO PLUGGED CHEMICAL FEED LINE TO THE CLARIFIER AFTER RESTART. AROUND JUNE 10, THE SYSTEM WAS SHUTDOWN BECAUSE OF SIMILAR PLUGGING IN ANOTHER PART OT THE LINE. THE UNIT RAN FOR ABOUT TWO WEEKS IN JUNE.

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JUL.-AUG. 75
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THE FGD SYSTEM WAS DOWN IN JULY AND AUGUST FOR REPLACEMENT OF GRAVITY FLOW LINE WITH AN OPEN FLUME.

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OCT. 75   2331     1848          79
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THE FGD SYSTEM RESTARTED ON SEPTEMBER 8, AND OPERATED DURING THIS PERIOD AT AN AVAILABILITY FACTOR OF 80 PERCENT. THE FIGURES GIVEN FOR OCTOBER REPRESENT THE OPERATION HOURS FROM SEPTEMBER 8 TO NOVEMBER 9.

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DEC. 75   2135     1250          59
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THE FGD SYSTEM OPERATED WELL DURING THE REPORT PERIOD EXCEPT FOR A SCHEDULED HOLIDAY SHUTDOWN FROM DECEMBER 23 TO JANUARY 4, 1976. BECAUSE OF PROBLEMS WITH SOLIDS AND SOLIDS CARRY-OVER, G.M. CON-

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

GENERAL MOTORS CORPORATION; PARMA, OHIO (CONTINUED)

	OPERATION HOURS		
MONTH	BOILER	FGD SYSTEM	OPERABILITY (%)

DUCTED STREAM TESTS DURING DECEMBER TO DETERMINE WHETHER THE CARRY-OVER OF SOLIDS WAS DUE TO A HIGH SOLIDS RECIRCULATION RATE. THE FGD SYSTEM WAS DOWN MOST OF DECEMBER BECAUSE OF THESE TESTS, WHICH CAUSED THE LOW OPERABILITY FACTOR.

FEB. 76	2997	1196	40

G.M. HAS FOUND SOLIDS CONCENTRATION IN THE CLARIFIER TOO HIGH FOR EFFICIENT SYSTEM OPERATION. A.D. LITTLE WAS SCHEDULED TO CONDUCT TESTS ON THE SYSTEM IN APRIL AS PART OF AN EPA EVALUATION PROGRAM.

MAR. 76	1379	240	7
APR. 76	1089	847	78

THE LOW OPERABILITY INDEX DURING THE MONTH OF MARCH RESULTED FROM EXTENSIVE MODIFICATIONS PERFORMED ON THE SYSTEM BY G.M. DURING THIS PERIOD THE SCRUBBER BLOWDOWN AND SCRUBBER FLOW INDICATION SYSTEM WAS REVISED. FROM APRIL 19 TO THE END OF THE MONTH THE SYSTEM WAS OPERABLE 100%. DURING THIS PERIOD ALL SYSTEM MODIFICATIONS WERE COMPLETED AND ALL MAJOR PROBLEM AREAS CORRECTED.

MAY 76	1149	1042	91
JUN. 76	924	816	88

ONE SYSTEM UPSET OCCURRED DURING THE PERIOD DUE TO AN OPERATOR ERROR. BOILER HOURS WERE LOW IN JUNE BECAUSE OF LOW PROCESS DEMAND. THE SCRUBBING SYSTEM CHARACTERIZATION STUDY WAS CONCLUDED ON MAY 14.

JUL. 76	599	599	100
AUG. 76	715	715	100

THE BOILER LOAD DEMAND WAS VERY LIGHT DURING THE REPORT MONTHS, REQUIRING ONLY ONE BOILER BEING CONTINUOUSLY ON LINE. THE SYSTEM WAS DOWN FOR A ONE-WEEK PERIOD BECAUSE OF THE ANNUAL PLANT INVENTORY. MODIFICATIONS TO THE OPERATION OF THE OF THE GAS SCRUBBING SYSTEM HAVE INCLUDED:

ELIMINATION OF POLYMERIC ADDITION.

ELIMINATION OF SLUDGE BLANKET FOR FILTRATION.

HIGH PERCENT SULFATE CONCENTRATION IN THE FILTER CAKE.

INCORPORATION OF PH CONTROLLER IN THE CHEMICAL MIX TANK REGULATING THE LIME FEED INTO SYSTEM. PH CONTROL SHOULD REDUCE THE STOICHIOMETRIC REQUIREMENTS FROM THE 1.25-1.50 RANGE DOWN TO 1.10-1.20.

SEP. 76	809	223	40
OCT. 76	1174	734	63

TWO BOILERS AND THEIR CORRESPONDING SCRUBBER MODULES WERE IN SERVICE DURING THE MONTH. OPERATION TIME WAS LODGED PRIMARILY IN THE INITIAL PART OF THE MONTH. A NUMBER OF PROBLEMS WERE ENCOUNTERED, FORCING A SHUTDOWN THROUGHOUT THE REMAINDER OF THE MONTH. THESE INCLUDED:

SOLIDS DEPOSITION AND PLUGGING OF THE CHEMICAL TANKS AND REACTORS, REQUIRING SHUTDOWN/CLEANOUT.

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

GENERAL MOTORS CORPORATION; PARMA, OHIO (CONTINUED)

	OPERATION HOURS		
MONTH	BOILER	FGD SYSTEM	OPERABILITY (%)

REPLACEMENT OF DEMISTER PADS.

AGITATOR PROBLEMS.

THE SYSTEM WAS RETURNED TO SERVICE THE SECOND WEEK IN OCTOBER. TWO BOILERS AND THEIR CORRESPONDING SCRUBBERS WERE PUT BACK IN THE GAS STREAM. PROBLEMS ENCOUNTERED STEMMED PRIMARILY FROM A MECHANICAL COLLECTOR MALFUNCTIONING RESULTING IN EXCESSIVE PARTICULATE LOADING IN THE MODULES AND EVENTUALLY CAUSING WIDESPREAD PLUGGING OF THE LOWER BUBBLE-CAP TRAYS. SHUTDOWN AND CLEANOUT OF MODULES PLUS REPAIRS TO THE MECHANICAL COLLECTOR WERE REQUIRED. SYSTEM RESTART OCCURRED NOVEMBER 8.

MAJOR MODIFICATIONS PERFORMED TO THE DOUBLE ALKALI SYSTEM DURING THE PERIOD INCLUDED THE INSTALLATION OF A GREAT LAKES PH MONITOR AND CONTROL UNIT FOR THE REGULATION OF LIME FEED TO THE REGENERATION REACTOR-CLARIFIER UNIT. THIS UNIT EMPLOYS A DIGITAL READOUT AND WAS SCHEDULED FOR OPERATION SOMETIME IN NOVEMBER. SUPERIOR CRYSTAL GROWTH OF THE CALCIUM SULFITE/SULFATE SALTS RESULTED BY RUNNING A SEEDING LINE BACK TO THE REACTOR-CLARIFIER UNIT.

NOV. 76	1321	787	60
DEC. 76	1559	349	22

DURING THE LATTER PART OF NOVEMBER AND EARLY DECEMBER, THE SCRUBBERS WERE TAKEN OUT OF THE FLUE GAS PATH BECAUSE OF CONTINUED SOLIDS BUILDUP IN THE MIX TANK. IN ADDITION, SOME PIPING ARRANGEMENTS WERE MODIFIED AND THE GEAR REDUCER IN THE MIX TANK HAD TO BE REPLACED. THE FGD FIGURES REPORTED FOR THE MONTH OF DECEMBER ARE NOT FULLY REPRESENTATIVE BECAUSE IT IS PART OF THE LOCAL UAW CONTRACT THAT ONLY UAW PERSONNEL CAN OPERATE THE FGD SYSTEM AND THEREFORE THE SCRUBBERS COULD NOT BE OPERATED.

JAN. 77	1852	608	33
FEB. 77	1462	892	61

THERE WAS A FAILURE OF THE AGITATORS AT THE MIX TANKS. THEY WERE LATER REPLACED WITH NEW ONES.

THE PLANT WAS SHUTDOWN FOR SOME PERIOD DUE TO CUTBACK OF NATURAL GAS SUPPLY AND REQUEST TO CURTAIL ELECTRICAL CONSUMPTION.

APR. 77	1300	1158	89
MAY 77	1222	1118	92

BOILER HOURS WERE LOW DUE TO REDUCED SUMMER REQUIREMENTS.

JUN. 77	1180	1103	94
JUL. 77	702	276	39

THE FGD SYSTEM GAVE A VERY HIGH OPERABILITY FOR JUNE. THE FGD SYSTEM WAS DOWN FOR A CONSIDERABLE PORTION OF JULY. THE CHEMICAL MIX TANK BLEED OFF LINES AND OTHER PIPING HAD TO BE CLEANED OF SEDIMENTED SOLIDS.

AUG. 77	755	678	90
SEP. 77	769	480	71

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

GENERAL MOTORS CORPORATION; PARMA, OHIO (CONTINUED)

DURING THIS LOW-LOAD PERIOD THE LIME FEED PUMP AND LIME FEED LINES WERE CLEANED. GENERALLY, EVERY SUMMER AN ANNUAL FGD OVERHAUL IS CARRIED OUT.

	OPERATION HOURS		
MONTH	BOILER	FGD SYSTEM	OPERABILITY (%)
OCT. 77	1277	398	31
NOV. 77	1380	920	67
DEC. 77	1790	968	54

THE CHEMICAL MIX TANK AGITATORS WERE TOTALLY REDESIGNED AND REPLACED BY HIGH-CARBON STEEL, PROPELLER TYPES. THE BLADES WERE SPECIFICALLY DESIGNED TO INCREASE THE FLOW THROUGH THE PROPELLERS, THUS INCREASING THE INTENSITY OF MIXING. DUE TO THANKSGIVING HOLIDAYS IN NOVEMBER AND CHRISTMAS AND NEW YEAR HOLIDAYS IN DECEMBER, THE FGD SYSTEM HAD LOWER OPERATION HOURS. SOME OF THE BOILERS HAD TO BE RUN FOR BUILDING MAINTENANCE.

1ST QUARTER-1978 THE BOILERS OPERATED FOR 3370 HOURS WHEREAS THE FGD OPERATED FOR 70 HOURS. THE OPERABILITY INDEX WAS THEREFORE 1.25%. THE RAKE SHAFT IN THE THICKENER WAS BROKEN IN EARLY JANUARY. THERE WAS A CONSIDERABLE DELAY IN RECEIVING REPLACEMENT PARTS. IN ADDITION, SEVERE WINTER (BLIZZARD, HEAVY SNOW) MADE IT IMPOSSIBLE TO PERFORM ANY REPAIRS.

2ND QUARTER-1978 THE FGD SYSTEM OPERATED FOR 2669 HOURS, AND THE BOILERS OPERATED FOR 3414 HOURS. THE OVERALL OPERABILITY WAS 78.2 PERCENT. IN APRIL, THE PIPELINES WERE FLUSHED AND CHEMICAL TANKS WERE CLEANED ALONG WITH SCRUBBER INTERNALS, STACKS AND MIST ELIMINATORS. IN JUNE, THE AVAILABILITY WAS 100 PERCENT. DURING THE SUMMER QUARTER, USUALLY A LOW-LOAD PERIOD, SEVERAL MODIFICATIONS WERE SCHEDULED. NEW VACUUM PUMPS AND FILTERS WILL BE INSTALLED, AND THE LIME SLURRY FEED PUMPS WILL BE REPLACED BY DIAPHRAGM PUMPS TO AVOID PLUGGING OF CONTROL VALVES. THE NEW FILTER CLOTH, MADE OF POLYPROPYLENE, HAS GIVEN MUCH LONGER FILTERING LIFE (ABOUT 3 MONTHS) THAN THE OLD ONE, MADE OF NYLON. THIS IS DUE TO THE POOR FILTERING CHARACTERISTICS OF THE NYLON (PLUGGING).

3RD QUARTER-1978 FOR THIS PERIOD THERE HAS BEEN NO DOWNTIME DUE TO EQUIPMENT OR PROCESS FAILURE. WARREN-RUPP DIAPHRAGM PUMPS WERE INSTALLED TO REPLACE THE EXISTING LIME SLURRY FEED PUMPS. THE PLANT REPORTED 100% OPERABILITY.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	GENERAL MOTORS CORPORATION
INSTALLATION LOCATION	PONTIAC, MICHIGAN
SOURCE CHARACTERISTICS	COAL (0.84% SULFUR) ALSO WOOD, PAPER, AND CARDBOARD.
SOURCE RATING	107,300 SCFM (TOTAL - 2 BOILERS) 350,000 LB/HR STEAM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	53 MW (EQUIVALENT); TOTAL - 2 BOILERS
CONTROL SYSTEM VENDOR	PEABODY ENGINEERING
CONTROL PROCESS	SODIUM HYDROXIDE SCRUBBING
NEW / RETROFIT	NEW
START-UP DATE	APRIL, 1976 SYSTEM OPERATED TWO MONTHS IN EARLY 1973.
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	NOT DETERMINED
PARTICULATE REMOVAL EFFICIENCY	85%
WATER MAKE-UP	OPEN LOOP; 50 GPM
SLUDGE OR BY-PRODUCT DISPOSAL	DEWATERED SLURRY TO LANDFILL 5% SOLIDS SLURRY DEWATERED AND TO LANDFILL
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE GENERAL MOTORS TRUCKS AND COACH PLANT LOCATED AT PONTIAC, MICHIGAN OPERATES TWO BOILERS TO GENERATE STEAM FOR PROCESS REQUIREMENTS. BOILER NO. 6, INSTALLED IN 1972 BY ERIE CITY, IS RATED AT 188 MM BTU/HR OR 150,000 LBS/HR OF STEAM. BOILER NO. 8, INSTALLED IN 1972 BY RILEY, IS RATED AT 250 MM BTU/HR OR 200,000 LBS/HR OF STEAM. THE FUEL USED IS COAL (0.84 % SULFUR), AND SOLID REFUSE (PAPER AND CARDBOARD). THE PARTICULATE EMISSIONS ARE CONTROLLED BY MECHANICAL COLLECTORS SUPPLIED BY ZURN INDUSTRIES, DESIGNED TO OPERATE AT 93% EFFICIENCY, WITH A PRESSURE DROP OF ABOUT 3 IN. WG.

PEABODY ENGINEERING SUPPLIED 2 WET SCRUBBERS IN APRIL 1976, PRIMARILY FOR ADDITIONAL PARTICULATE CONTROL. EACH SCRUBBER(12 FEET DIA x 21.5 FEET HIGH) CONTAINS 3 IMPINGEMENT TRAYS AND OPERATES WITH A L/G OF 5 GAL/1000 ACF. THE SCRUBBER EFFLUENT IS MIXED WITH CAUSTIC AND MAKEUP WATER IN A HOLD TANK, AND PUMPED TO A CLARIFIER. THE OVERFLOW IS RECYCLED TO THE SCRUBBER, THUS SIGNIFICANT SO2 CONTROL IS ACHIEVED. THE UNDERFLOW IS SENT TO A WASTE TREATEMENT PLANT, WHERE THE FLYASH IS REMOVED AND LANDFILLED. THE EFFLUENT DISCHARGE FROM THE WASTE TREATMENT PLANT IS 10 - 25 GPM.

THE SCRUBBERS, TRAYS, AND MIST ELIMINATORS (RADIAL VANE TYPE) ARE ALL MADE OF 316L SS.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

GENERAL MOTORS CORPORATION; PONTIAC, MICHIGAN (CONTINUED)

OPERATING HISTORY

2ND QUARTER-1976 UNSTABLE PH CONTROL AND WEAR OF MECHANICAL EQUIPMENT HANDLING THE FLYASH SLURRY WERE MAJOR STARTUP PROBLEMS.

3RD QUARTER-1977 AN AVAILABILITY OF 100 PERCENT HAD BEEN REPORTED WHEN BURNING A MIXTURE OF COAL AND REFUSE. THE SCRUBBER DISCHARGE SLURRY CAUSED WEAR DUE TO ITS FLYASH CONTENT.

4TH QUARTER-1977 FLYASH ABRASION IN THE PUMPS AND PIPING CONTINUED TO BE THE PROBLEM.

1ST QUARTER-1978 FLYASH CAUSED SERIOUS EROSION OF LIQUID HANDLING EQUIPMENT.

2ND QUARTER-1978 IT WAS DECIDED TO INSTALL PRESSURE FILTERS IN THE SCRUBBER EFFLUENT LINES TO REMOVE FLYASH.

3RD QUARTER-1978 THE PRESSURE FILTERS WERE INSTALLED AND ARE WORKING WELL. NO OTHER PROBLEMS OCCURRED DURING THE REPORT PERIOD.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	GENERAL MOTORS CORPORATION
INSTALLATION LOCATION	ST. LOUIS, MISSOURI
SOURCE CHARACTERISTICS	COAL (3.2% SULFUR)
SOURCE RATING	64,000 SCFM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	32 MW (TOTAL - 2 BOILERS)
CONTROL SYSTEM VENDOR	A.D. LITTLE
CONTROL PROCESS	SODIUM HYDROXIDE SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	1972
CONTROL SYSTEM STATUS	OPERATIONAL
SO_2 REMOVAL EFFICIENCY	90+% (2000 PPM @ INLET)
PARTICULATE REMOVAL EFFICIENCY	REMOVED BY PRECEDING CYCLONE AND ESP
WATER MAKE-UP	OPEN LOOP
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT AND DISCHARGE TO CITY SEWER NA_2SO_3 OXIDIZED TO NA_2SO_4, PH NEUTRALIZED AND DISCHARGED TO CITY SEWER SYSTEM
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE GENERAL MOTORS CORPORATION PLANT LOCATED IN ST. LOUIS, MISSOURI OPERATES 4 COAL-FIRED BOILERS. TWO BOILERS, WHICH ARE RATED AT A TOTAL OF 32 MW (EQUIVALENT) AND HAVE A TOTAL STEAM GENERATION CAPACITY OF 250,000 LB/HR, ARE EQUIPPED WITH SCRUBBERS. COAL COMPOSITION IS TYPICALLY 3.2% SULFUR AND 10% ASH. SULFUR DIOXIDE CONCENTRATION IS APPROXIMATELY 2100 PPM AT THE INLET TO EACH SCRUBBER. CYCLONES AND ESP'S ARE USED FOR PARTICULATE REMOVAL PRIOR TO SO_2 REMOVAL IN A 3-STAGE IMPINGEMENT TOWER WITH A CHEVRON MIST ELIMINATOR. DIRECT REHEAT IS ACCOMPLISHED WITH STEAM COILS

THE FGD SYSTEM IS CONSTRUCTED OF 316L STAINLESS STEEL.

OPERATING HISTORY

3RD QUARTER-1977	AN OPERABILITY OF 100% WAS REPORTED DURING THE MAY-AUGUST PERIOD.
4TH QUARTER-1977	IN SPITE OF A CHEVRON DEMISTER AND 60 F REHEAT, THE STACK LINER WAS CORRODED.
1ST QUARTER-1978	THE DUCTWORK DOWNSTREAM OF THE SCRUBBERS DEVELOPED SOME LEAKS.
2ND QUARTER-1978	A HORIZONTAL PORTION OF THE DOWNSTREAM DUCTWORK,ABOUT 15-20 FEET IN LENGTH, WILL BE REDESIGNED TO AVOID STAGNATION OF EXHAUST GASES
3RD QUARTER-1978	THE DOWNSTREAM DUCTWORK WAS RECONSTRUCTED DURING THE REPORT PERIOD.

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	GENERAL MOTORS CORPORATION
INSTALLATION LOCATION	TONOWANDA, NEW YORK
SOURCE CHARACTERISTICS	COAL (1.2% SULFUR)
SOURCE RATING	92,000 SCFM (TOTAL - 4 BOILERS) 36,000 ACFM @ 406 F, FOR EACH OF 3 FGD SYSTEMS 39,600 ACFM @ 350 F, FOR 1 FGD SYSTEM 340,000 LB/HR STEAM (TOTAL - 4 BOILERS)
NUMBER OF SEPARATE FGD UNITS	4
NUMBER OF BOILERS BEING CONTROLLED	4
SOURCE CAPACITY	46 MW (EQUIVALENT); TOTAL - 4 BOILERS
CONTROL SYSTEM VENDOR	FMC ENVIRONMENTAL EQUIPMENT
CONTROL PROCESS	SODIUM HYDROXIDE SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	JUNE, 1975
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	90%-95% (1,000 PPM @ INLET)
PARTICULATE REMOVAL EFFICIENCY	90% (1.0 LB/MM BTU AT INLET)
WATER MAKE-UP	OPEN LOOP
SLUDGE OR BY-PRODUCT DISPOSAL	DEWATERED SLURRY TO LANDFILL FLY ASH AND NA2SO3/SO4 WASTE LIQUOR DEWATERED AND THEN TO SANITARY LANDFILL
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE CHEVROLET DIVISION OF GENERAL MOTORS HAS A MOTOR PRODUCTION PLANT AT TONOWANDA, NEW YORK. THERE ARE 4 COAL-FIRED BOILERS AT THE FACILITY WHICH BURN 1.16 PERCENT SULFUR COAL WITH A HEATING VALUE OF 12,650 BTU/LB. THE TOTAL COAL FEED RATE IS 17 TONS/HR WHICH IS EQUIVALENT TO 412 MM BTU/HR OF HEAT INPUT OR 340,000 LBS/HR OF STEAM. THE BOILERS ARE RATED AT A TOTAL OF 46 MW.

ONE SCRUBBER HANDLES 39,000 ACFM AT 350 F WHEREAS EACH OF THE OTHER THREE 36,000 ACFM AT 406 F. THERE IS A CYCLONE BEFORE AND AFTER SCRUBBER FOR DUST COLLECTION AND MIST REMOVAL PURPOSES, RESPECTIVELY. THE VARIABLE THROAT VENTURI SCRUBBERS WERE SUPPLIED BY FMC CORP. THE PH OF RECYCLE SCRUBBER LIQUOR IS CONTROLLED AT 7.0 AND A L/G RATIO OF 20 GALLONS/1000 ACF IS USED. PRESSURE DROP ACROSS EACH SCRUBBER IS 13 IN. WG. CAUSTIC SODA IS ADDED TO THE SPENT LIQUOR IN A SEPARATE RECYCLE TANK. THE BLEED OFF RATE FROM THE RECYCLE TANK VARIES FROM 25 - 100 GPM. THE DISCHARGE CONTAINS FLYASH AND SODIUM SULFATE. THE FLYASH IS CONTROLLED AT LESS THAN 1% SUSPENDED SOLIDS. THE EFFLUENT IS DISCHARGED TO THE WASTE TREATMENT PLANT AFTER AERATION. THE AVERAGE INLET CONCENTRATIONS ARE 0.85 LB/MM BTU OF SO2 AND 1 LB/MM BTU OF PARTICULATE. THE EFFICIENCY OF SO2 REMOVAL IS 90% WHEREAS

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

GENERAL MOTORS CORPORATION; TONOWANDA, NEW YORK (CONTINUED)

THAT OF PARTICULATE REMOVAL IS 80%-95%.

EACH SCRUBBER AND THE CYCLONIC DEMISTER IS MADE OF 316L SS. PLUME REHEAT IS NOT INCORPORATED INTO THE SYSTEM. THE ENERGY REQUIREMENTS FOR THE SYSTEM ARE ABOUT 3 - 5% OF THE FUEL BURNED.

OPERATING HISTORY

3RD QUARTER-1977   AVERAGE OPERABILITY DURING THIS PERIOD WAS REPORTED TO BE 100%.

4TH QUARTER-1977   MAJOR PROBLEMS HAVE BEEN PH CONTROL AND RECYCLE PIPE EROSION. CONTROL SENSORS/MODULATING MIXER VALVE REPLACED FOR PH CONTROL AND CAST IRON PIPE WAS USED TO REPLACE SS RECYCLE PIPING. DURING NOV - DEC CONDENSATION FOLLOWING THE DEMISTER HAS CORRODED THE STACK LINING. A DECISION HAS BEEN MADE TO RELINE THE STACK.

1ST QUARTER-1978   THE STACK WAS NOT RELINED.

2ND QUARTER-1978   ONE MORE CYCLONE WILL BE RETROFITTED AFTER EACH BOILER IN ORDER TO REDUCE THE PARTICULATE LOADING TO THE SCRUBBERS.

3RD QUARTER-1978   A MIST ELIMINATOR WILL BE INSTALLED TO PREVENT FURTHER CORROSION OF THE STACK LINER. THE LINER WILL EITHER BE REPLACED OR COATED WITH AN ACID-RESISTANT MATERIAL.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	GEORGIA-PACIFIC PAPER CO.
INSTALLATION LOCATION	CROSSETT, ARKANSAS
SOURCE CHARACTERISTICS	BARK,COAL/OIL (1% - 1.5% SULFUR)
SOURCE RATING	220,000 SCFM (1 BOILER)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	1
SOURCE CAPACITY	110 MW (EQUIVALENT); 1 BOILER
CONTROL SYSTEM VENDOR	AIRPOL INDUSTRIES
CONTROL PROCESS	CAUSTIC WASTE STREAM
NEW / RETROFIT	NEW
START-UP DATE	1975
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	85% - 90% (500 PPM @ INLET)
PARTICULATE REMOVAL EFFICIENCY	90% (0.5 GR/SCF AT INLET)
WATER MAKE-UP	OPEN LOOP; SCRUBBED WITH 2,300 GPM "BLACK WATER" FROM PULP MILL.
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT AND DISCHARGE TO CITY SEWER
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE FGD SYSTEM AT GEORGIA-PACIFIC PAPER CO., CROSSETT, ARKANSAS UTILIZES A CAUSTIC PULP MILL WASTEWATER STREAM (BLACK WATER) TO REMOVE PARTICULATE AND SO2 FROM FLUE GAS GENERATED BY A BARK/OIL OR BARK/COAL BOILER. THE BOILER IS AN ERIE CITY POWER BOILER RATED AT 600,000 LBS. STEAM/HOUR (110 MW EQUIVALENT). THE NORMAL OPERATING RANGE IS BETWEEN 400,000 AND 500,000 LBS STEAM/HOUR WITH AN OPERATING SCHEDULE OF 24 HOURS/DAY 359 DAYS/YEAR. IT IS ONE OF ELEVEN BOILERS THAT TURN 5 TURBINES AND GENERATE 45 MW.

THE FLUE GAS IS DUCTED TO A SINGLE SCRUBBER AT THE RATE OF 320,000 ACFM @ 310 F BY MEANS OF A BUFFALO FORGE I.D. FAN WHICH IS DRIVEN BY A 4000 HP WESTINGHOUSE TURBINE. THE SCRUBBER ITSELF IS MADE OF 304 SS AND CONSISTS OF AN UNLINED VENTURI THROAT (9.5 FT X 50 FT) AND AN UNLINED LIQUID-GAS SEPARATOR (24 FT X 55 FT) WITH NO INTERNAL PARTS. THE DUCTING LEADING TO AND FROM THE SCRUBBER IS MADE OF STEEL AND THE DOWNSTREAM PORTION IS FIBERGLASS LINED. NO MIST ELIMINATION OR REHEAT IS USED BECAUSE THE 304 SS STACK IS FIBERGLASS LINED. THE RECIRCULATION SYSTEM CONSISTS OF A 304 SS UNLINED RECIRCULATION TANK AND A 5000 GPM INGERSOLL-RAND PUMP. AN IDENTICAL SPARE PUMP IS ALSO ON HAND BUT IS NOT TIED INTO THE SYSTEM. THESE PUMPS ARE MADE OF 304 SS AND ARE RUBBER LINED. THEY OPERATE AT MAXIMUM CAPACITY. THE PIPING IS MADE OF FIBERGLASS. THE BLEED STREAM FROM THE RECIRCULATION SYSTEM IS FED TO THE CITY SEWERS AT A RATE OF 2000 GPM AND THE MAKE-UP SCRUBBING LIQUOR IS FED TO THE SYSTEM AT A RATE OF 2300 GPM.

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

GEORGIA-PACIFIC PAPER CO.; CROSSETT, ARKANSAS (CONTINUED)

OPERATING HISTORY

3RD QUARTER-1977 PLANT REPORTED SATISFACTORY OPERATIONS WITH NO MAJOR PROBLEMS. THE FIBERGLASS LINING IN THE SCRUBBER FAILED FREQUENTLY AND WAS REPLACED AS IT FAILED.

4TH QUARTER-1977 NO FIBERGLASS LINER FAILURE WAS DETECTED DURING THIS REPORT PERIOD.

2ND QUARTER-1978 PLANT REPORTED NO MAJOR PROBLEMS DURING THE FIRST SIX MONTHS OF 1978. TOTAL BOILER-SCRUBBER DOWNTIME SINCE JANUARY 1, WAS ABOUT 15 DAYS. THE PROBLEMS WERE THE LOSS OF A PUMP LINER AND A BOILER I.D. FAN TROUBLE.

3RD QUARTER-1978 THE PUMP WITH LINING PROBLEMS WAS REPLACED. THIS CAUSED A SCRUBBER DOWN TIME OF APPROXIMATELY 36 HOURS. THE REASON FOR THE PUMP FAILURE IS UNKNOWN, BUT UNEVEN LINING APPLICATION IS LIKELY. THIS PUMP LASTED ROUGHLY 3 MONTHS BEFORE THE LINING OF THE IMPELLER BEGAN COMING OFF IN CHUNKS. THE NEW PUMP IS THE SAME TYPE AND HAS HAD NO PROBLEMS. THE SPARE IS ALSO OF THE SAME TYPE. SINCE REPLACEMENT OF THE RECIRCULATION PUMP THE SCRUBBER HAS OPERATED CONTINUOUSLY (SCRUBBER SHUTS DOWN WHEN THE RECIRCULATION PUMP GOES OUT).

SECTION 3 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	GETTY OIL COMPANY
INSTALLATION LOCATION	BAKERSFIELD, CALIFORNIA
SOURCE CHARACTERISTICS	COAL (1.1% SULFUR)
SOURCE RATING	72,000 SCFM (TOTAL - 6 BOILERS)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	6
SOURCE CAPACITY	36 MW (EQUIVALENT); 6 BOILERS, EACH @ 50 MM BTU/HR
CONTROL SYSTEM VENDOR	FMC ENVIRONMENTAL EQUIPMENT
CONTROL PROCESS	SODIUM CARBONATE SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	JUNE, 1977
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	90+% (600 PPM @ INLET)
SLUDGE OR BY-PRODUCT DISPOSAL	HOLDING POND FOR EVAPORATION 10 GPM BLEEDOFF TO A BLOWDOWN TANK. THE BLOWDOWN IS THEN SENT TO A DISPOSAL POND ONCE A WEEK.
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

GETTY OIL COMPANY HAS AN OIL FIELD NEAR BAKERSFIELD, CALIFORNIA WHICH OCCUPIES ABOUT 15 SQUARE MILES. THERE ARE 136 STEAM GENERATORS: 100 WITH A HEAT RATE OF 50 MM BTU/HR AND 36 WITH A HEAT RATE OF 20 MM BTU/HR. THE FUEL USED IS CRUDE OIL WITH 1.1% SULFUR AND A HEATING VALUE OF 6.4 MM BTU/BBL. STEAM IS DISTRIBUTED THROUGHOUT THE OIL FIELD BY INSULATED PIPELINES AND INJECTED INTO THE OIL WELLS. CONDENSATION OF THE STEAM REDUCES THE VISCOSITY OF THE OIL, WHICH FLOWS FREELY TO THE SURFACE ALONG WITH THE WATER. THE OIL IS SEPARATED FROM WATER BY DECANTATION IN SETTLING TANKS, AND PURIFIED BY DISTILLATION IF REQUIRED.

THE FLUE GASES (130,000 ACFM @ 500 F) FROM SEVEN BOILERS (50 MM BTU/HR) ARE MANIFOLDED INTO A TRAY ABSORBER (13.5 FEET DIA X 35 FEET HIGH) WHICH WAS RETROFITTED IN JUNE 1977 BY FMC ENVIRONMENTAL EQUIPMENT DIVISION. OF THE SEVEN, FIVE ARE USUALLY OPERATING AT ONE TIME; OPERATION IS 24 HR/DAY. THE PROCESS IS SODIUM CARBONATE SCRUBBING. THE LIQUOR IS MAINTAINED AT A PH OF 6.8, AND RECIRCULATED WITH AN L/G RATIO OF 6.6 GAL/1000 ACF. THE RECIRCULATION FLOW IS 1000 GPM. A BLEED STREAM OF 10 GPM IS CONTINUALLY SENT TO THE BLOWDOWN TANK WHICH IS EITHER EMPTIED INTO A DISPOSAL POND OR INJECTED INTO DEEP WELLS EVERY WEEK. THE INLET SO2 CONCENTRATION IS 600 PPM; THE OUTLET IS [illegible] 60 PPM. THE ABSORBER, THEREFORE, HAS 90+% SO2 REMOVAL EFFICIENCY. THE ORIGINAL ABSORBER CONTAINED THREE DISC-AND-DONUT TRAYS AND AN INCONEL WIRE MESH MIST ELIMINATOR.

THE ABSORBER MODULE AND THE STACK ARE MADE OF 316L SS, WHEREAS THE DOWNSTREAM DUCTWORK AND THE RECIRCULATION PIPING ARE MILD STEEL. THE RECIRCULATION PUMP IS RUBBER LINED. THE CAPITAL COST FOR

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

GETTY OIL COMPANY: BAKERSFIELD, CALIFORNIA (CONTINUED)

THE FGD SYSTEM WAS $400,000 IN 1977 DOLLARS, WHICH INCLUDES ALL THE EQUIPMENT BUT DOES NOT INCLUDE STACK DUCTING, OVERHEADS, AND ENGINEERING. THE OPERATING COSTS ARE $0.16/MM BTU ($[illegible]/YR FOR [illegible] DAYS/YR), WHICH INCLUDE ELECTRICAL, SCRUBBER MAINTENANCE, AND SODA ASH. THE STOICHIOMETRIC RATIO IS 1.61 LBS OF NA2CO3/LB SO2 REMOVED.

SOME IMPORTANT MAINTENANCE PRACTICES ARE:

1. DAILY CHECK AND CALIBRATION OF PH CONTROLLERS.
2. FREQUENT CHECKS ON FLOW RATERS (MAKEUP WATER, SODA ASH, RECIRCULATION LIQUOR, AND BLOWDOWN) AND FLUID LEVELS (BLOWDOWN TANK, SODA ASH TANK, AND SCRUBBER).
3. WEEKLY FILLING OF SODA ASH TANK AND DISPOSAL OF BLOWDOWN.
4. SCHEDULED LUBRICATION OF PUMPS AND FAN, SEAL REPLACEMENT.

REFER TO FIGURE 14-8 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

3RD QUARTER-1977   THE RECIRCULATION PUMP LINER WAS CHANGED FROM BUNA-N TO NATURAL RUBBER, DUE TO THE SWELLING OF THE FORMER LINER. THE RUBBER PINCH VALVE ON THE RECIRCULATION PUMP WAS REPLACED BY A SS GLOBE VALVE. THERE WERE SOME MINOR PROBLEMS WITH THE PH AND LEVEL CONTROLLERS.

4TH QUARTER-1977   THE FAN ROTOR WAS STRENGTHENED AND CLEANED OF THE SCALING. THE FAN BEARING BURNED UP. IT WAS REPLACED AND THE FAN WAS REALIGNED.

1ST QUARTER-1978   HIGH STACK DISCHARGE VELOCITY (60 FPS) CAUSED BY SMALL STACK DIAMETER AND POOR LOCATION OF MIST ELIMINATOR (TOO CLOSE TO STACK TRANSITION SECTION) RESULTED IN HIGH ENTRAINMENT OF DROPLETS. THE STACK AND TOP SECTION OF THE SCRUBBER WERE REDESIGNED.

2ND QUARTER-1978   THE MESH DEMISTER WAS TO BE REPLACED BY A MUNTERS CHEVRON TYPE MIST ELIMINATOR. A KOCH FLEXITRAY WAS TO BE INSTALLED ABOVE THE 3RD TRAY IN ORDER TO IMPROVE SO2 REMOVAL EFFICIENCY, PARTICULARLY DURING TURNDOWN CONDITIONS. THE PH PROBES ARE FOULED FREQUENTLY. SEVERAL TYPES OF CONTROLLERS ARE PRESENTLY BEING TESTED FOR HIGH RELIABILITY. THE MILD STEEL RECIRCULATION LINES WERE ERODED, AND WILL BE REPLACED BY 316L SS. THE AIR BUBBLER IN THE SODA ASH TANK LEVEL CONTROLLER IS OFTEN PLUGGED. IT WILL BE REPLACED BY A DIAPHRAGM-TYPE LEVEL CONTROL DEVICE. THE BLOWDOWN TANK OUTLET LINE HAS DEVELOPED SCALING. A POSITIVE DISPLACEMENT PUMP WAS TO BE INSTALLED IN THIS LINE, AND A SCALING INHIBITOR WAS POSSIBLY TO BE ADDED IN THE TANK LIQUOR.

3RD QUARTER-1978   THE BLOWDOWN TANK OUTLET LINE WAS REPLACED WITH A ONE-INCH LINE TO INCREASE VELOCITY AND THUS SOLVE THE SCALING PROBLEM. NEW 316L SS RECIRCULATION LINES HAVE BEEN INSTALLED, AS HAS THE DIAPHRAGM-TYPE LEVEL CONTROL DEVICE IN THE SODA ASH TANK. PH CONTROLLERS ARE STILL BEING TESTED. A SCREW-TYPE POSITIVE DISPLACEMENT PUMP WAS INSTALLED, REPLACING AN EARLIER PUMP WHICH ERODED DUE TO HIGH RPM. A SILICON DISPERSANT IS NOW BEING ADDED TO THE LIQUOR TO ASSIST IN

GETTY OIL COMPANY; BAKERSFIELD, CALIFORNIA (CONTINUED)

ALLEVIATING THE SCALING PROBLEM, BUT THERE HAS NOT BEEN SUFFICIENT TIME TO EVALUATE ITS EFFECTIVENESS. SINCE AUGUST 7 THE SYSTEM HAS EXPERIENCED ONLY 2 DAYS DOWNTIME DUE TO REPLACEMENT OF FAN BEARINGS.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	GREAT SOUTHERN PAPER CO.
INSTALLATION LOCATION	CEDAR SPRINGS, GEORGIA
SOURCE CHARACTERISTICS	BARK,COAL/OIL (1.0% - 2.0% SULFUR)
SOURCE RATING	420,000 SCFM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	100 MW (EQUIVALENT); TOTAL - 2 BOILERS
CONTROL SYSTEM VENDOR	AIRPOL INDUSTRIES
CONTROL PROCESS	CAUSTIC WASTE STREAM
NEW / RETROFIT	RETROFIT
START-UP DATE	1975
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	85%-90% (1,000 PPM AT INLET)
PARTICULATE REMOVAL EFFICIENCY	99.1% (DESIGN: 4.5 GR/SCF AT INLET)
WATER MAKE-UP	OPEN LOOP; 350 - 400 GPM PER ABSORBER
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT AND DISCHARGE TO RIVER CLARIFICATION FOLLOWED BY PONDING AND DISCHARGE TO RIVER
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE FGD SYSTEM AT GREAT SOUTHERN PAPER AT CEDAR SPRINGS, GEORGIA CONSISTS OF TWO AIRPOL SODIUM SCRUBBING TRAINS CONTROLLING EMISSIONS FROM TWO COAL-FIRED BOILERS, EACH RATED AT 105 MW (EQUIVALENT) AND EACH PRODUCING 500,000 LB/HR STEAM. THE FUELS FIRED IN THE BOILERS TYPICALLY HAVE THE FOLLOWING SULFUR CONTENTS: COAL - 1.5% , OIL - 1.5%, AND BARK - 2.0%.

THE STAINLESS STEEL SCRUBBERS HANDLE A COMBINED TOTAL OF 700,000 ACFM AT 425 DEGREES F. THE PRESSURE DROP ACROSS A SCRUBBER IS APPROXIMATELY 7 INCHES W.G. WITH 85 - 90% SULFUR DIOXIDE REMOVAL EFFICIENCY. THE SULFUR CONCENTRATION OF THE FLUE GAS IS 1000 - 1200 PPM AND THE PARTICULATE LOADING IS 4.5 GR/SCFD.

THE SCRUBBER UNDERFLOW IS COMPOSED OF FLYASH AND SODIUM SULFITE/SULFATE SOLUTION. SOLIDS CONTENT (FLYASH) IS TYPICALLY 3 TO 5% BY WEIGHT. SCRUBBER WASTE WATER WITH AN AVERAGE PH OF 4.5 IS PONDED AND CLARIFIED WATER IS RETURNED TO THE RIVER.

OPERATING HISTORY

4TH QUARTER-1977 THE EXPANSION JOINT BETWEEN THE EXISTING STACK AND SCRUBBER HAD TO BE REPLACED IN SEPTEMBER. SOME INTERNAL WEAR WAS DETECTED ON THE PUMPS DUE TO THE ASH CONTENT. EROSION AND PLUGGING PROBLEMS WITH THE PH PROBES HAVE BEEN ENCOUNTERED. THE PLANT WAS IN THE PROCESS OF CHANGING THE CONTROL PH AND MOVING THE PROBES. TANKS AND NECESSARY EQUIPMENT TO CONTROL THE PROPER PH

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

GREAT SOUTHERN PAPER CO.; CEDAR SPRINGS, GEORGIA (CONTINUED)

ARE EXPECTED TO BE COMPLETED IN A COUPLE OF MONTHS. SOME EROSION WAS DETECTED IN THE RECIRCULATION LINES OF THE POWER BOILER SCRUBBER. THE LINES AND SOME OF THE VALVES HAD TO BE REPLACED.

2ND QUARTER-1978 NO UPDATE INFORMATION WAS OBTAINED FOR THIS REPORT PERIOD.

3RD QUARTER-1978 NO SCRUBBER-RELATED PROBLEMS WERE REPORTED FOR THIS PERIOD.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	GREAT WESTERN SUGAR
INSTALLATION LOCATION	BILLINGS, MONTANA
SOURCE CHARACTERISTICS	COAL (0.7% SULFUR)
SOURCE RATING	60,000 SCFM (TOTAL - 3 BOILERS)
NUMBER OF SEPARATE FGD UNITS	3
NUMBER OF BOILERS BEING CONTROLLED	3
CONTROL SYSTEM VENDOR	GREAT WESTERN SUGAR
CONTROL PROCESS	AMMONIA-LADEN PROCESS WATER
NEW / RETROFIT	RETROFIT
START-UP DATE	OCTOBER, 1977
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	35% (300-400 PPM @ INLET)
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT AND DISCHARGE TO RIVER
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE FGD SYSTEM AT GREAT WESTERN SUGAR, BILLINGS, MONTANA PLANT HAS BEEN PRIMARILY DESIGNED FOR PARTICULATE CONTROL. HOWEVER, THE SCRUBBING LIQUOR CONTAINS ENOUGH NH3 (PH=8.7) TO OBTAIN A REMOVAL EFFICIENCY OF 35% FOR SO2. THE CONCENTRATION OF SO2 AT THE INLET IS 300-400 PPM. THE SYSTEM CONSISTS OF A VARIABLE THROAT VENTURI SCRUBBER AND A SINGLE PASS, THREE STAGE CHEVRON DEMISTER. THE SCRUBBER WAS INSTALLED IN OCTOBER, 1977 AND HAS BEEN OPERATING SATISFACTORILY.

THE SCRUBBER EFFLUENT IS BLED OFF TO A POND WHERE IT IS BLENDED AND COOLED WITH OTHER PROCESS WASTE STREAMS AND THEN PUMPED TO A RIVER.

OPERATING HISTORY

3RD QUARTER-1978   NO INFORMATION WAS REPORTED FOR THIS UPDATE PERIOD.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	GREAT WESTERN SUGAR
INSTALLATION LOCATION	FINDLAY, OHIO
SOURCE CHARACTERISTICS	COAL (1.2% SULFUR, AVERAGE)
SOURCE RATING	65,230 SCFM (TOTAL - 2 BOILERS) 100,000 LBS/HR STEAM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	33 MW (EQUIVALENT), 90MM BTU/HR (TOTAL); TOTAL - 2 BOILERS
CONTROL SYSTEM VENDOR	GREAT WESTERN SUGAR
CONTROL PROCESS	SODIUM CARBONATE SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	OCTOBER, 1974
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	76% (600 PPM @ INLET)
PARTICULATE REMOVAL EFFICIENCY	90%
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT AND DISCHARGE TO CITY SEWER BLEED-OFF STREAM TO HOLDING TANK
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE GREAT WESTERN SUGAR COMPANY HAS TWO COAL-FIRED BOILERS AT THE FINDLAY, OHIO PLANT. EACH BOILER IS RATED AT 50,000 LBS/HR OF STEAM; AND BURNS COAL WITH 1.2 PERCENT AVERAGE SULFUR, 9.2 PERCENT AVERAGE ASH, AND A HEATING VALUE OF 12,715 BTU/LB. THE SUGAR FACTORY IS OPERATIONAL ONLY 3 MONTHS OF EVERY YEAR, DURING THE FALL QUARTER.

THE FGD SYSTEM WAS RETROFITTED IN OCT. 1974 AS A PROPRIETARY DESIGN PRIMARILY FOR PARTICULATE CONTROL. THE FLUE GASES FROM TWO BOILERS (120,000 ACFM @ 515 F) PASS THROUGH MULTICLONES, AND THEN ARE SENT THROUGH A VENTURI SCRUBBER, WHICH OPERATES WITH A PRESSURE DROP OF 7 IN. OF WG AND L/G VALUE OF 7 GAL/1000 ACF. THE GAS VELOCITY AT THE VENTURI INLET IS 44 FPS. THE SCRUBBER IS FOLLOWED BY A DEMISTER VESSEL WHICH CONTAINS A SINGLE PASS, THREE-STAGE CHEVRON DEMISTER. WASH WATER FLOW TO THE DEMISTER IS 120 GPM, WITH A FREQUENCY OF 15 MINUTES EVERY 8 HOURS. THE PRESSURE DROP ACROSS THE DEMISTER IS .5 IN. WG. A CONSTANT BLEED-OFF STREAM OF 300 GPM IS SENT TO A POND. A PART OF THIS POND IS REUSED AS MAKEUP WATER TO THE SCRUBBER, WHILE THE BALANCE OVERFLOWS INTO ANOTHER HOLDING POND.

THE VENTURI SCRUBBER, THE PLUG, DEMISTER VESSEL, AND THE DEMISTER ARE ALL MADE OF 316L SS.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	GREAT WESTERN SUGAR
INSTALLATION LOCATION	FORT MORGAN, COLORADO
SOURCE CHARACTERISTICS	COAL (1.2% SULFUR, AVERAGE)
SOURCE RATING	65,230 SCFM (TOTAL - 2 BOILERS) 100,000 ACFM EACH @ 400 F (TOTAL - 2 BOILERS) 250,000 LBS/HR STEAM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	326 MM BTU/HR, 32 MW (EQUIVALENT); TOTAL - 2 BOILERS
CONTROL SYSTEM VENDOR	GREAT WESTERN SUGAR
CONTROL PROCESS	AMMONIA-LADEN PROCESS WATER
NEW / RETROFIT	RETROFIT
START-UP DATE	OCTOBER, 1976
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	48% (300-400 PPM @ INLET)
PARTICULATE REMOVAL EFFICIENCY	95% (730 LBS/HR @ INLET)
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT AND DISCHARGE TO RIVER
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE GREAT WESTERN SUGAR COMPANY HAS TWO COAL FIRED BOILERS AT THEIR FORT MORGAN, COLORADO PLANT. EACH BOILER IS RATED AT 125,000 LBS/HR OF STEAM; AND BURNS COAL WITH 0.54 PERCENT AVERAGE SULFUR, 8.7 PERCENT AVERAGE ASH, AND AN AVERAGE HEATING VALUE OF 10,176 BTU/LB. THE SUGAR FACTORY IS OPERATIONAL ONLY 3 MONTHS OF EVERY YEAR, DURING THE FALL QUARTER.

THE FGD SYSTEM WAS RETROFITTED IN OCTOBER 1976 AS A PROPRIETARY DESIGN PRIMARILY FOR PARTICULATE CONTROL. THE FLUE GASES FROM EACH BOILER (100,000 ACFM @ 400 F) PASS THROUGH MULTICLONES, AND THEN ARE SENT THROUGH A VENTURI SCRUBBER, WHICH OPERATES WITH A PRESSURE DROP OF 6 IN. W.G. AND L/G VALUE OF 8 GAL/1000 ACF. THE SCRUBBERS ARE FOLLOWED BY A COMMON VESSEL WHICH CONTAINS A SINGLE-PASS, THREE-STAGE CHEVRON MIST ELIMINATOR (M-E). WASH WATER FLOW TO THE M-E IS 120 GPM, WITH A FREQUENCY OF 15 MINUTES EVERY 8 HOURS. THE PRESSURE DROP ACROSS THE M-E IS 0.5 IN. W.G. A CONSTANT BLEED-OFF STREAM OF 800 GPM FROM EACH SCRUBBER IS SENT TO A POND, WHICH OVERFLOWS INTO ANOTHER HOLDING POND.

THE VENTURI SCRUBBER, THE PLUG, M-E VESSEL, AND THE M-E ARE ALL MADE OF 316L SS.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	GREAT WESTERN SUGAR
INSTALLATION LOCATION	GERING, NEBRASKA
SOURCE CHARACTERISTICS	COAL (1.2% SULFUR, AVERAGE)
SOURCE RATING	110,000 SCFM (TOTAL - 2 BOILERS) 97,000 ACFM EACH @ 450 F (TOTAL - 2 BOILERS) 205,000 LBS/HR STEAM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	21 MW (EQUIVALENT); TOTAL - 2 BOILERS (1 @ 15, 1 @ 6) 218 MM BTU/HR (TOTAL)
CONTROL SYSTEM VENDOR	GREAT WESTERN SUGAR
CONTROL PROCESS	AMMONIA-LADEN PROCESS WATER
NEW / RETROFIT	RETROFIT
START-UP DATE	OCTOBER, 1975
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	70% (600 PPM @ INLET)
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT AND DISCHARGE TO RIVER EFFLUENT TO HOLDING POND
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE GREAT WESTERN SUGAR COMPANY HAS TWO COAL-FIRED BOILERS AT THEIR GERING, NEBRASKA PLANT. BOILER #1 IS RATED AT 150,000 LBS/HR OF STEAM AND WAS SUPPLIED BY ERIE CITY IN 1965. BOILER #2 IS RATED AT 55,000 LB/HR OF STEAM AND WAS SUPPLIED BY ERIE CITY IN 1954. THE COAL HAS 0.73 PERCENT AVERAGE SULFUR, 8.5 PERCENT AVERAGE ASH, AND AN AVERAGE HEATING VALUE OF 10,180 BTU/LB. THE SUGAR FACTORY IS OPERATIONAL ONLY 3 MONTHS OF EVERY YEAR, DURING THE FALL QUARTER.

THE FGD SYSTEM WAS RETROFITTED IN OCTOBER 1975 AS A PROPRIETARY DESIGN PRIMARILY FOR PARTICULATE CONTROL. THE FLUE GASES FROM TWO BOILERS (105,000 ACFM @ 310 F) PASS THROUGH CYCLONES, ARE MIXED IN A COMMON DUCT, AND THEN SENT THROUGH TWO VENTURI SCRUBBERS (EACH HEATING 97,000 ACFM @ 450 F), WHICH OPERATE WITH A PRESSURE DROP OF 6 IN. W.G. AND L/G VALUE OF 6.2 GAL/ACF. THE OPERATING GAS VELOCITY AT THE VENTURI INLET IS 43 FPS. THE SCRUBBERS ARE FOLLOWED BY A MIST ELIMINATOR (M-E) VESSEL WHICH CONTAINS A SINGLE-PASS, THREE-STAGE CHEVRON M-E. WASH WATER FLOW TO THE M-E IS 150 GPM, WITH A FREQUENCY OF 15 MINUTES EVERY 8 HOURS. THE PRESSURE DROP ACROSS THE M-E IS 0.5 IN. W.G. THE SCRUBBER EFFLUENT, 700 GPM FROM EACH SCRUBBER, IS SENT TO A POND.

THE VENTURI SCRUBBERS, VARIABLE DIAMETER PLUGS, M-E VESSEL, AND M-E ARE ALL MADE OF 304L SS.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	GREAT WESTERN SUGAR
INSTALLATION LOCATION	GREELEY, COLORADO
SOURCE CHARACTERISTICS	COAL (0.6% SULFUR)
SOURCE RATING	25,000 SCFM (1 BOILER)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	1
CONTROL SYSTEM VENDOR	GREAT WESTERN SUGAR
CONTROL PROCESS	AMMONIA-LADEN PROCESS WATER
NEW / RETROFIT	RETROFIT
START-UP DATE	OCTOBER, 1975
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	35% (300-400 PPM @ INLET)
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT AND DISCHARGE TO RIVER
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

AT THE GREELY, COLORADO PLANT, GREAT WESTERN SUGAR HAS IN OPERATION 6 COAL FIRED BOILERS MANUFACTURED BY STERING AND PLACED IN SERVICE IN 1920. THE BOILERS OPERATE 2796 HOURS PER YEAR DURING THE FALL AND EARLY WINTER MONTHS. EACH BOILER POSSESSES THE FOLLOWING CHARACTERISTICS; AN OPERATING HEAT INPUT OF 29.7 MM BTU/HR, A DESIGN STEAM CAPACITY OF 12,225 LB/HR AND A DESIGN FLUE GAS FLOW RATE OF 28,333 ACFM @ 550 F. THE COAL USED AS FUEL HAS AN AVERAGE HEATING VALUE OF 9208 BTU/LB, AN AVERAGE SULFUR CONTENT OF 0.66% AND AN AVERAGE ASH CONTENT OF 5.39%.

THE SCRUBBER SYSTEM IS A WET VENTURI FOLLOWED BY A CHEVRON TYPE, ONE PASS MIST ELIMINATOR. THE MIST ELIMINATOR IS CONSTRUCTED OF 3/16" 316 STAINLESS STEEL AND THE SCRUBBER IS CONSTRUCTED OF 10 GA. 316L SS. DEMISTER WASH FLOW RATE IS 120 GPM. DESIGN FLUE GAS FLOW RATE IS 164,000 ACFM @ 550 F AND THE L/G RATIO IS 5.5 GAL/1000 CFM. THE FLOW OF SCRUBBING LIQUOR TO THE VENTURI IS 550 GPM. THE PRESSURE DROP ACROSS THE SCRUBBER IS 7" WG.

THE WASTE WATER FROM THE SCRUBBER IS AN ASH/WATER SLURRY WHICH IS CONTINUOUSLY DISCHARGED TO A POND AT 1100 GPM.

OPERATING HISTORY

3RD QUARTER-1978   NO INFORMATION WAS REPORTED FOR THIS REPORT PERIOD.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	GREAT WESTERN SUGAR
INSTALLATION LOCATION	LOVELAND, COLORADO
SOURCE CHARACTERISTICS	COAL (1.2% SULFUR, AVERAGE)
SOURCE RATING	121,600 SCFM (TOTAL - 2 BOILERS) 100,000 ACFM EACH @ 410 F 100,000 LBS/HR STEAM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
CONTROL SYSTEM VENDOR	GREAT WESTERN SUGAR
CONTROL PROCESS	AMMONIA-LADEN PROCESS WATER
NEW / RETROFIT	RETROFIT
START-UP DATE	OCTOBER, 1973
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	30% (.95 LB/MM BTU @ INLET)
WATER MAKE-UP	800 GPM (PROCESS CONDENSATE WATER, PH=6.7, L/G=8)
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT AND DISCHARGE TO RIVER EFFLUENT STREAM TO HOLDING POND
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE GREAT WESTERN SUGAR COMPANY HAS TWO COAL-FIRED BOILERS AT THEIR LOVELAND, COLORADO PLANT. EACH BOILER IS RATED AT 125,000 LBS/HR OF STEAM AND BURNS COAL WITH 0.52 PERCENT AVERAGE SULFUR, 9.9 PERCENT AVERAGE ASH, AND AN AVERAGE HEATING VALUE OF 10,345 BTU/LB. THE SUGAR FACTORY IS OPERATIONAL ONLY 3 MONTHS OF EVERY YEAR, DURING THE FALL QUARTER.

THE FGD SYSTEM WAS RETROFITTED IN OCTOBER 1974 AS A PROPRIETARY DESIGN PRIMARILY FOR PARTICULATE CONTROL. THE FLUE GASES FROM EACH BOILER (100,000 ACFM @ 410 F) PASS THROUGH CYCLONES AND ARE MIXED IN A COMMON DUCT, AND THEN SENT THROUGH TWO VENTURI SCRUBBERS, WHICH OPERATE WITH A PRESSURE DROP OF 7 IN. W.G. AND L/G VALUE OF 7.5 GAL/1000 ACF. THE OPERATING GAS VELOCITY AT THE VENTURI INLET IS 43 FPS. THE SCRUBBERS ARE FOLLOWED BY A MIST ELIMINATOR (M-E) VESSEL WHICH CONTAINS A ONE-PASS, THREE-STAGE CHEVRON M-E. WASH WATER FLOW TO THE M-E IS 120 GPM, WITH A FREQUENCY OF 15 MINUTES EVERY 8 HOURS. THE PRESSURE DROP ACROSS THE M-E IS 0.5 IN. W.G. THE EFFLUENT STREAM FROM EACH SCRUBBER, 750 GPM, IS SENT TO A POND, WHICH OVERFLOWS INTO ANOTHER HOLDING POND.

THE VENTURI SCRUBBERS, VARIABLE DIAMETER PLUGS, M-E VESSEL, AND THE M-E ARE ALL MADE OF 316L SS.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	GREAT WESTERN SUGAR
INSTALLATION LOCATION	SCOTTS BLUFF, NEBRASKA
SOURCE CHARACTERISTICS	COAL (1.2% SULFUR, AVERAGE)
SOURCE RATING	65,230 SCFM (TOTAL - 2 BOILERS) 130,000 ACFM EACH @ 400 F (TOTAL - 2 BOILERS) 300,000 LBS/HR STEAM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	32 MW (EQUIVALENT); TOTAL 2 - BOILERS 315 MM BTU/HR (TOTAL)
CONTROL SYSTEM VENDOR	GREAT WESTERN SUGAR
CONTROL PROCESS	AMMONIA-LADEN PROCESS WATER
NEW / RETROFIT	RETROFIT
START-UP DATE	OCTOBER, 1975
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	35% (400 PPM @ INLET)
PARTICULATE REMOVAL EFFICIENCY	95%
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT AND DISCHARGE TO RIVER EFFLUENT STREAM TO HOLDING POND.
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE GREAT WESTERN SUGAR COMPANY HAS TWO COAL-FIRED BOILERS AT THEIR SCOTTS BLUFF, NEBRASKA PLANT. EACH BOILER IS RATED AT 150,000 LBS/HR OF STEAM AND BURNS COAL WITH 0.61 PERCENT AVERAGE SULFUR, 5.2 PERCENT AVERAGE ASH, AND AN AVERAGE HEATING VALUE OF 9,300 BTU/LB. THE SUGAR FACTORY IS OPERATIONAL ONLY 3 MONTHS OF EVERY YEAR, DURING THE FALL QUARTER.

THE FGD SYSTEM WAS RETROFITTED IN OCTOBER 1975 AS A PROPRIETARY DESIGN PRIMARILY FOR PARTICULATE CONTROL. THE FLUF GASES FROM TWO BOILERS (130,000 ACFM EACH @ 400 F) PASS THROUGH CYCLONES AND ARE MIXED, AND THEN SENT THROUGH TWO VENTURI SCRUBBERS, WHICH OPERATE WITH A PRESSURE DROP OF 6 IN. W.G. AND L/G VALUE OF 6.5 GAL/1000 ACF. THE OPERATING GAS VELOCITY AT THE VENTURI INLET IS 56 FPS. THE SCRUBBERS ARE FOLLOWED BY A DEMISTER VESSEL WHICH CONTAINS A SINGLE-PASS, THREE-STAGE CHEVRON MIST ELIMINATOR (M-E). WASH WATER FLOW TO THE M-E IS 150 GPM, WITH A FREQUENCY OF 10 MINUTES EVERY 4 HOURS. THE PRESSURE DROP ACROSS THE M-E IS 0.5 IN. W.G. THE SCRUBBER EFFLUENT, 825 GPM FROM EACH SCRUBBER, IS SENT TO A POND.

THE VENTURI SCRUBBERS, VARIABLE DIAMETER PLUGS, M-E VESSEL, AND THE M-E ARE ALL MADE OF 316L SS.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	ITT RAYONIER, INC.
INSTALLATION LOCATION	FERNANDINA BEACH, FLORIDA
SOURCE CHARACTERISTICS	BARK,OIL (2.0% - 2.5% SULFUR)
SOURCE RATING	201,000 SCFM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	4
SOURCE CAPACITY	100 MW (EQUIVALENT): TOTAL - 4 BOILERS
CONTROL SYSTEM VENDOR	AIRPOL INDUSTRIES
CONTROL PROCESS	SODIUM HYDROXIDE SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	1975
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	80% - 85% (1,200 PPM AT INLET)
PARTICULATE REMOVAL EFFICIENCY	97% (1.7 GR/SCF AT INLET)
WATER MAKE-UP	OPEN LOOP
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT AND DISCHARGE TO TAILINGS POND
CONTROL SYSTEM COST	SEE SECTION 15 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

ITT RAYONIER OPERATES AN AMMONIA-BASED SULFITE PULP MILL IN FERNANDINA BEACH, FLORIDA. THERE ARE FOUR PROCESS STEAM BOILERS. TWO RATED AT 125,000 LB/HR STEAM, ONE AT 100,000 LB/HR STEAM AND ONE AT 150,000 LB/HR STEAM.

FLUE GASES LEAVING THE NUMBER TWO AND THREE BOILERS ENTER INTO SEPARATE MECHANICAL COLLECTORS (BUELL CYCLONE COLLECTORS) FOR PARTICULATE REMOVAL OF ABOUT 97% (1.7 GR/SCF @ INLET). TWO IDENTICAL FGD SYSTEMS ARE USED TO REMOVE 80 TO 85 PERCENT OF THE SO2 FROM THE GAS FROM ALL FOUR BOILERS. BOILERS ONE AND TWO ARE MANIFOLDED INTO ONE SCRUBBER SYSTEM WHILE GASES FROM THREE AND FOUR ARE MANIFOLDED INTO THE SECOND SCRUBBER SYSTEM. EACH SYSTEM USES A VARIABLE-THROAT VENTURI SCRUBBER FOR SO2 REMOVAL WHICH IS PRECEEDED BY AN I.D. FAN. A 10% CAUSTIC SOLUTION IS INJECTED AT THE THROAT OF THE VENTURI FOR USE AS THE SCRUBBING LIQUOR. CONTROL PH IS IN THE RANGE OF 5.5 TO 6.0. THE LIQUID-GAS MIXTURE ENTERS A SEPARATOR (38 FT HIGH X 16.9 FT DIA.) WHICH INCORPORATES SPIN VANES FOR LIQUID SEPARATION. THE LIQUID DROPS TO THE BOTTOM OF THE SEPARATOR INTO THE RECIRCULATION TANK. THE PUMPS OPERATE AT 75 HP DURING FULL LOAD REQUIREMENTS. THE GASES LEAVE THE TOP OF THE SEPARATOR AND LEAD DIRECTLY TO THE STACK.

THE VENTURIS, SEPARATORS (INCLUDING SPIN VANES), SPENT LIQUOR PIPING AND HOLD TANKS ARE ALL CONSTRUCTED OF 316L SS.

REFER TO FIGURE 14-7 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

ITT RAYONIER, INC.; FERNANDINA BEACH, FLORIDA (CONTINUED)

OPERATING HISTORY

4TH QUARTER-1977 PLANT REPORTED THAT BOILERS NO. 2 AND 3 WERE OPERATING AT REDUCED LOADS, EACH IN THE RANGE OF 75,000 - 90,000 LBS/HR STEAM. THE SPENT CAUSTIC WAS NOT BEING USED FOR SCRUBBING LIQUOR. ITT WAS SELLING THE SPENT CAUSTIC TO KRAFT MILLS WHO USE IT FOR THEIR SODA BASE. CONDENSATE STEAM WAS BEING RECYCLED AND USED FOR SCRUBBING PURPOSES. SOME EROSION HAS BEEN NOTED AT THE VENTURI THROAT.

2ND QUARTER-1978 THE PLANT WAS STILL UTILIZING CONDENSATE WATER FOR SCRUBBER LIQUOR. APPROXIMATELY 3 TONS PER DAY OF SODIUM HYDROXIDE WAS BEING USED TO MAINTAIN PH. THE ORIGINAL HOT WASTE STREAM CAUSTIC WAS NOT USED FOR SCRUBBER PURPOSES, BECAUSE OF PROCESS-RELATED PROBLEMS THAT DEVELOPED.
SCRUBBER EFFLUENT WAS STILL BEING SOLD TO KRAFT MILLS. THE SYSTEM HAS TWO SCRUBBERS, "A" AND "B". A-MODULE WAS DOWN 4 WEEKS IN JUNE AND JULY BECAUSE OF AN F.D. FAN FAILURE, BELIEVED TO BE A RESULT OF POORLY OPERATED MECHANICAL COLLECTORS. NEW MECHANICALS WERE BEING INSTALLED TO PREVENT FURTHER ABRASION. THE PLANT REPORTED THAT SINCE JANUARY, SCRUBBER OPERABILITY HAD BEEN APPROXIMATELY 95%.

3RD QUARTER-1978 THE BOILER AND FGD SYSTEM OPERATED APPROXIMATELY 95% OF THE PERIOD. THE ONLY OUTAGE DURING THE PERIOD WAS BOILER-RELATED AND LASTED THREE DAYS. THE BEARINGS IN THE I.D. FAN HAD TO BE REPLACED.

SECTION 4 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	KERR-MCGEE CHEMICAL CORP.
INSTALLATION LOCATION	TRONA, CALIFORNIA
SOURCE CHARACTERISTICS	COKE/COAL/OIL (0.5% - 5.0% SULFUR)
SOURCE RATING	490,000 SCFM (TOTAL - 2 BOILERS) 726,000 ACFM @ 320 F (TOTAL - 2BOILERS)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	64 MW (ELECTRIC POWER AND PROCESS STEAM) TOTAL - 2 BOILERS
CONTROL SYSTEM VENDOR	COMBUSTION EQUIPMENT ASSOC.
CONTROL PROCESS	SODIUM CARBONATE SCRUBBING
NEW / RETROFIT	NEW
START-UP DATE	JUNE, 1978
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	98+% (AT MAXIMUM LOADING)
PARTICULATE REMOVAL EFFICIENCY	98.5% (COLLECTED BY PRECEDING ESP'S)
WATER MAKE-UP	OPEN LOOP, 125 GPM BURKITE SCRUBBING LIQUOR (47% NA2CO3 AND 41% NA2SO4)
SLUDGE OR BY-PRODUCT DISPOSAL	HOLDING POND FOR EVAPORATION SCRUBBER EFFLUENT IS CLARIFIED AND THEN PUT INTO A MINERAL DEPOSIT.
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

KERR-MCGEE CHEMICAL CORP. HAS A NEW 1.3 MM TON/YR SODA ASH PLANT AT TRONA, CALIFORNIA. THE PLANT, LOCATED ALONG THE SHORE OF SEARLES LAKE, IS THE LARGEST YET BUILT TO YIELD SODA ASH BY DIRECT CARBONATION OF BRINE AND WAS COMMISSIONED IN JUNE 1978. THE PROCESSING INNOVATIONS, WHICH HAVE IMPROVED THE PLANT EFFICIENCY, INCLUDE CARBONATION UNDER 13.5 LB/SQ. IN. PRESSURE, USE OF A COAL-FIRED POWER PLANT, AND RECOVERY OF CO2 FROM THE FLUE GASES.

THE PLANT HAS TWO BOILERS, EACH RATED AT 32 MW, WHICH PRODUCE PROCESS STEAM AND ELECTRICITY. EACH BOILER PRODUCES 600,000 LBS/HR OF STEAM AT 1500 PSI AND BURNS A MIXTURE OF WESTERN COAL (0.7 PERCENT SULFUR) AND PETROLEUM COKE (5.5 PERCENT SULFUR). THE HIGH SULFUR COKE IS MIXED WITH THE COAL IN ORDER TO IMPROVE THE PARTIAL IONIZATION AND THEREFORE IMPROVE FLY-ASH COLLECTION IN THE ESP WHICH OPERATES ON THE COLD SIDE OF THE PREHEATER AT 98.5 PERCENT EFFICIENCY AND 300 F. THE FLUE GAS FLOW RATE FROM EACH BOILER IS 363,000 ACFM AT 320 F AND MAY CONTAIN SO2 BETWEEN 335 TO 5985 PPM DEPENDING UPON THE FUEL. THE AIR POLLUTION REGULATIONS DICTATE THAT EACH BOILER MAY RELEASE NOT MORE THAN 10 LBS/HR PARTICULATE, 200 LBS/HR OF SO2 AND 140 LBS/HR OF NOX.

THE FLUE GASES ARE SCRUBBED BY THE FGD LIQUOR FROM THE SODA ASH PLANT IN TWO SCRUBBERS

KERR-MCGEE CHEMICAL CORP.; TRONA, CALIFORNIA (CONTINUED)

(30 FT DIA X 35 FT HIGH EACH) WHICH ARE MILD STEEL VESSELS WITH FLAKE LINING AND POLYPROPYLENE SIEVE TRAYS. THE TOP TRAY RECEIVES PLAIN WATER WHEREAS THE SECOND TRAY RECEIVES THE RECIRCULATING LIQUOR AT PH OF 6 - 6.5. THE SPENT LIQUOR FROM THE BOTTOM OF THE SCRUBBERS IS RECIRCULATED BY RUBBER LINED PUMPS TO A MILD STEEL SURGE TANK WHERE FRESH END-LIQUOR IS ADDED TO IT WITHOUT AGITATION. A BLEED OFF STREAM IS CONTINUOUSLY TAKEN BACK TO THE SALT PONDS.

THE BOILER I.D. FANS (1600 HP) FORCE THE GASES THROUGH THE SCRUBBERS AND EXPERIENCE 6 IN. WG PRESSURE DROP. THE FANS HAVE MILD STEEL CASING. THE DOWNSTREAM DUCTWORK IS MILD STEEL WITH FLAKE LINING WHEREAS THE STACK IS CONCRETE WITH FRP LINER. AMBIENT AIR IS HEATED IN AN EXTERNAL STEAM HEATER AND MIXED WITH THE EXIT FLUE GASES TO INCREASE THE TEMPERATURE FROM 125 F TO ABOUT 175 F. AT MAXIMUM LOADING, THE SCRUBBERS HAVE A SO2 REMOVAL EFFICIENCY OF 98 PERCENT. THE SCRUBBED FLUE GASES ARE PROCESSED THROUGH TWO MONOETHANOLAMINE (MEA) PLANTS FOR EXTRACTION OF CO2. EACH MEA PLANT WILL PRODUCE 300 TONS/DAY OF CO2 AND WILL BE THE MAIN SOURCE OF MAKEUP CO2 FOR THE CARBONATION STEP.

REFER TO FIGURE 14-10 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

1ST QUARTER-1978 THE MAJOR CONSTRUCTION WORK WAS OVER. PRECOMMISSIONING ACTIVITIES WERE UNDERWAY. THE PLANT WAS PROJECTED TO GO ONSTREAM BY APRIL 1, 1978.

2ND QUARTER-1978 THE FGD SYSTEM WAS COMMISSIONED DURING THE REPORT PERIOD. THE BOILERS WERE RUN TO FULL CAPACITY WITH 100% OIL FEED. COAL AND COKE WERE USED UP TO 80% AS THE FUEL. THE MAJOR STARTUP PROBLEM WAS TRAY TIEDOWN. THE POLYPROPYLENE SIEVE TRAYS WERE NOT STRONG ENOUGH TO TAKE THE LOAD OF INVENTORY LIQUID. THESE WILL BE REPLACED BY 316L SS OR A HIGHER GRADE ALLOY. THE PRESENCE OF CHROMATE IONS IN THE MAKEUP WATER CAUSED SOME CONCERN.

3RD QUARTER-1978 THERE WERE ONLY 2 BOILER AND FGD OUTAGES DURING THE PERIOD. BOTH OUTAGES WERE FOR REPLACING THE SIEVE TRAYS IN THE ABSORBER MODULES. TRAYS WERE REPLACED BY 317L SST IN THE FIRST MODULE DURING A 5-DAY OUTAGE IN AUGUST, AND IN THE SECOND DURING A 4-DAY OUTAGE IN SEPTEMBER. COAL AND COKE WERE USED FOR 90 TO 95 PERCENT AS THE FUEL. OIL WAS NOT USED AT ALL, WHILE GAS WAS AVAILABLE ONLY AS A BACK-UP.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	MEAD PAPERBOARD CO.
INSTALLATION LOCATION	STEVENSON, ALABAMA
SOURCE CHARACTERISTICS	OIL (1.5% - 3% SULFUR)
SOURCE RATING	100,000 SCFM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	50 MW (EQUIVALENT); TOTAL - TWO BOILERS
CONTROL SYSTEM VENDOR	AIRPOL INDUSTRIES
CONTROL PROCESS	SODIUM HYDROXIDE SCRUBBING
NEW / RETROFIT	NEW
START-UP DATE	1975
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	95% (1,500 PPM @ INLET)
PARTICULATE REMOVAL EFFICIENCY	90%
SLUDGE OR BY-PRODUCT DISPOSAL	ALKALINE SULFITE/BISULFITE RECYCLED TO PULP PROCESS RECOVERED SOLUTION USED AS MAKE-UP TO COOKING LIQUOR IN PULP MILL.
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE MEAD PAPERBOARD COMPANY IN STEVENSON, ALABAMA, IS A NEUTRAL SULFITE PULP MILL WITH A 500 TON/DAY PULP PRODUCTION RATE. THE MILL HAS A CHEMICAL RECOVERY SYSTEM THAT ABSORBS SO2 FROM THE BILLERUD REACTOR. EFFLUENT FROM THE RECOVERY SYSTEM FLOWS BACK TO THE PULPING OPERATION. ELSEWHERE ON-SITE, AN AIRPOL INDUSTRIES ABSORBER TOWER CONTROLS PARTICULATE AND SO2 EMISSIONS FROM TWO OIL-FIRED (1.5% - 3.0% SULFUR) COMBUSTION-ENGINEERING PACKAGE BOILERS. FLUE GAS VOLUME INTO THE SCRUBBER SYSTEM IS ABOUT 175,000 ACFM @ 450 F. HOT GASES PASS THROUGH A STAINLESS STEEL VENTURI/QUENCH SECTION FOR COOLING AND INITIAL SO2 REMOVAL. THE FLUE GAS THEN ENTERS THE BOTTOM OF THE ABSORBER SECTION AND PASSES UP THROUGH THREE BUBBLE-CAP TRAYS. A SODIUM CARBONATE SOLUTION IS INTRODUCED THROUGH A BANK OF 1.5 INCH NOZZLES AND SPIN VANES. THE SOLUTION IS ADDED TO THE RECIRCULATION LINE ON THE SUCTION SIDE OF THE RECIRCULATION PUMP AT A RATE OF 20 - 25 GPM. SCRUBBER EFFLUENT (600 GPM), MOSTLY SODIUM SULFITE, IS SENT TO THE MILLS PULPING OPERATIONS FOR EVENTUAL USE IN THE FIBERGLASS RECIRCULATION TANK. THE PH MONITORING SYSTEM CONSISTS OF A FIBERGLASS BOX ACCEPTING OVERFLOW FROM THE RECYCLE TANK. THE GAS EXITS THROUGH A FIBERGLASS STACK.

THE SO2 SCRUBBING SYSTEM WAS DOWN FROM MARCH THROUGH JULY 1976 DUE TO ABRASION PROBLEMS. THE ABRASION WAS CAUSED PARTIALLY BY HIGH STREAM VELOCITY THROUGH THE EXISTENT VENTURI PARTICULATE SCRUBBER INTO THE SO2 SCRUBBER. SODIUM CARBONATE AND CARBON PARTICLES THAT HAD NOT GONE INTO SOLUTION ALSO WERE VERY ABRASIVE TO THE SO2 SCRUBBER LINING. IN ADDITION, THE ORIGINAL GLASS-FLAKED

MEAD PAPERBOARD CO.; STEVENSON, ALABAMA (CONTINUED)

LINER (5 MM THICK) WAS EXPERIENCING STRESS CRACKING.

THE HIGH VELOCITIES INTRODUCED BY THE VENTURI WERE ELIMINATED BY REMOVING THE PARTICULATE VENTURI SECTION OF THE SYSTEM. THE GLASS-FLAKED LINING WAS PATCHED WITH $60,000 WORTH OF CARPENTER 20 LINER. THESE CORRECTIVE ACTIONS HELPED FOR A WHILE, BUT AS IT TURNED OUT, THE CARPENTER 20 WAS NOT INSTALLED PROPERLY AND SOLUTION WAS GETTING BETWEEN IT AND THE MILD STEEL SHELL. IT WAS FINALLY DECIDED TO INSTALL NEW RUBBER LINING INSIDE THE ENTIRE SCRUBBER, INCLUDING THE SPIN VANES, AT A COST OF $150,000. TO PREVENT ANY HEAT PROBLEMS, ADDITIONAL NOZZLES WERE INSTALLED. TO DATE, NO MAJOR PROBLEMS HAVE OCCURRED WITH THE RUBBER LINING.

SCRUBBER MAINTENANCE IS PERFORMED WHENEVER MILL OPERATIONS CEASE FOR ROUTINE PLANT MAINTENANCE WHICH OCCURS SEVERAL TIMES PER YEAR. THE PH CONTROL SYSTEM RECEIVES CONTINUING MAINTENANCE AND THE PH PROBES ARE CLEANED ONCE PER WEEK.

REFER TO FIGURE 14-11 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

4TH QUARTER-1977 MINOR EMBRITTLEMENT, DUE TO LOCALIZED HIGH TEMPERATURE, HAS BEEN DETECTED ON THE LINING SURFACE. SOME METAL, NOZZLES, AND RUBBER HAVE BEEN REPLACED.

2ND QUARTER-1978 THE PLANT WAS DOWN 12 DAYS IN JUNE FOR A MAJOR PAPER MACHINE UPDATE, AND THE BOILERS WERE DOWN 9 DAYS DURING THAT PERIOD. DURING BOILER DOWN TIME, THE RUBBER LINERS IN THE ABSORBER MODULE WERE REPAIRED AND MODIFICATIONS WERE MADE AT THE INLET TO THE ABSORBER, REDIRECTING AIR FLOW TO MINIMIZE FURTHER FLY ASH ABRASION OF THE LINERS. THE PLANT REPORTED AN OPERABILITY OF 100% FOR THE FGD SYSTEM.

3RD QUARTER-1978 AN AVAILABILITY OF 100% WAS REPORTED FOR THE SCRUBBER SYSTEM DURING THIS PERIOD.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	MINN-DAK FARMER'S COOPERATIVE
INSTALLATION LOCATION	WAHPETON, NORTH DAKOTA
SOURCE CHARACTERISTICS	LIGNITE (1.0% SULFUR)
SOURCE RATING	160,000 SCFM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	80 MW (EQUIVALENT); TOTAL - 2 BOILERS TWO BOILERS, EACH @ 275,000 LBS/HR STEAM (250 PSIG - 455 F)
CONTROL SYSTEM VENDOR	KOCH ENGINEERING
CONTROL PROCESS	AMMONIA SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	JUNE, 1977
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	TESTS INCONCLUSIVE.
WATER MAKE-UP	200 GPM AMMONIACAL WASTE STREAM
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT BLEED STREAM GOES TO AN ACTIVATED SLUDGE SYSTEM @ 160 GPM
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

MINN-DAK FARMER'S COOP. HAS A SUGAR FACTORY AT WAHPETON, NORTH DAKOTA. THERE ARE TWO BOILERS, EACH WITH A CAPACITY OF 275,000 LBS STEAM/HR AT 250 PSIG AND 455 F. THE FUEL BURNED IS 1% SULFUR LIGNITE. SULFUR DIOXIDE REMOVAL IS EFFECTED BY AN AMMONIA WASTE STREAM FROM AN ON-SITE PROCESS ADDED TO THE RECIRCULATING SCRUBBER LIQUOR.

KOCH ENGINEERING HAS SUPPLIED TWO SCRUBBERS FOR THE BOILERS EACH OF WHICH GENERATES 125,000 ACFM OF FLUE GASES AT 350 F. THE SCRUBBER SYSTEMS WENT ONSTREAM IN JUNE 77. EACH SCRUBBER IS A VARIABLE THROAT VENTURI WITH OPEN ENDED PIPE INLETS FOR LIQUID AND WAS PRIMARLY DESIGNED FOR PARTICULATE CONTROL. THE SCRUBBER LIQUOR IS RECIRCULATED AT A RATE OF 800 GPM AND THE BLEED-OFF RATE GOING TO THE ACTIVATED SLUDGE SYSTEM IS 160 GPM. THE MAKEUP POND WATER FLOW RATE IS 200 GPM. THE PRESSURE DROP ACROSS A SCRUBBER IS 11 IN. WG. THERE IS ONE COMMON CHEVRON TYPE MIST ELIMINATOR AND ONE STACK. THE INLET CONCENTRATION RANGES ARE 76-193 LBS/HR OF SO2 AND .3-.4 GR/SCF OF PARTICULATE. THE OUTLET CONCENTRATION RANGES ARE 10-37 LBS/HR AND .027-.038 GR/SCF RESPECTIVELY.

THE SCRUBBERS AND THE LIQUOR INLET PIPES ARE MADE OF 316L SS, THE DEMISTER AND STACK ARE 316 SS, AND THE RECIRCULATING PIPING IS FIBERGLASS. THE TOTAL PURCHASE COST OF THE EQUIPMENT WAS $300,000 IN 1977 DOLLARS. INITIALLY THE SYSTEM WAS DESIGNED TO USE A LIME SLURRY OF PH 10.0 AS THE SCRUBBING LIQUOR. HOWEVER, DURING THE FIRST SIX WEEKS OF OPERATION, NUMEROUS PLUGGING AND SCALING PROBLEMS OCCURRED. HENCE, THE PLANT PERSONNEL BEGAN USING THE AMMONIA-RICH WASTE STREAM FROM ANOTHER ON-SITE

MINN-DAK FARMER'S COOPERATIVE : WAHPETON, NORTH DAKOTA (CONTINUED)

PROCESS IN EARLY 1978.

EACH YEAR, THE PLANT ONLY OPERATES FROM SEPTEMBER - FEBUARY. THIS IS THE BEET SUGAR PRODUCTION PERIOD. DURING THE REMAINDER OF THE YEAR, PRODUCTION DISTRIBUTION IS THE MAIN PLANT ACTIVITY.

OPERATING HISTORY

3RD QUARTER-1978 THE FGD SYSTEM BEGAN OPERATIONS FOR THE 1978-1979 SEASON ON SEPTEMBER 12. NO FGD-RELATED PROBLEMS OCCURRED. THE WASTE TREATMENT HAS BEEN MODIFIED TO INCLUDE AN ANAEROBIC DIGESTER FOLLOWED BY AN OPEN POND AND AN AEROBIC DIGESTER.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	MOBIL OIL CORPORATION
INSTALLATION LOCATION	SAN ARDO, CALIFORNIA
SOURCE CHARACTERISTICS	OIL (2.0% - 2.25% SULFUR)
SOURCE RATING	182,000 SCFM (TOTAL - 30 BOILERS) 8000 ACFM @ 470F, FOR EACH OF 22 FGD SYSTEMS 18,000 ACFM @ 470F, FOR EACH OF 8 FGD SYSTEMS
NUMBER OF SEPARATE FGD UNITS	30
NUMBER OF BOILERS BEING CONTROLLED	40
SOURCE CAPACITY	91 MW (EQUIVALENT); 840 MM BTU/HR: TOTAL - 30 BOILERS
CONTROL SYSTEM VENDOR	MOBIL OIL COMPANY
CONTROL PROCESS	SODIUM HYDROXIDE SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	1974
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	90% (1500 PPM @ INLET)
SLUDGE OR BY-PRODUCT DISPOSAL	HOLDING POND FOR EVAPORATION
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE MOBIL OIL COMPANY HAS AN OIL SITE IN SAN ARDO, CALIFORNIA WHERE 28 STEAM GENERATORS ARE USED TO FORCE OIL OUT OF WELLS BY A DEEP WELL STEAM INJECTION PROCESS. THE FUEL USED IS CRUDE OIL WITH 2 - 2.5% SULFUR. EACH STEAM GENERATOR IS FOLLOWED BY AN INDIVIDUAL FGD SYSTEM INSTALLED SPECIFICALLY FOR SO2 CONTROL. THE UNITS EXPERIENCED STARTUP IN THE PERIOD FROM 1972 THROUGH 1974.

THERE ARE TWO SIZES OF STEAM GENERATORS; 22MM BTU/HR (20 UNITS) AND 50MM BTU/HR (8 UNITS). THE SMALL UNITS GENERATE 8,000 SCFM, AND THE LARGE UNITS 18,000 SCFM. THE GASES ARE SCRUBBED BY A LIQUOR CONSISTING OF NAOH AND ALKALINE OIL FIELD WASTEWATER (NA2CO3). THE PROCESS IS ONCE-THROUGH AND PH VALUES OF 8.0 AND 6.0 ARE MAINTAINED AT THE INLET AND OUTLET OF THE SCRUBBERS, RESPECTIVELY. THE SPENT LIQUOR FROM THE BOTTOM OF THE SCRUBBERS IS DISPOSED OF IN THE WASTEWATER DISPOSAL ZONE. THERE IS NO RECYCLE FROM THE DISPOSAL ZONE. THE LIQUOR FLOW RATES TO THE TWO SIZES OF THE SCRUBBERS ARE 75 GPM AND 200 GPM. THE SCRUBBER SIZES ARE 4 FT DIAMETER X 20 FT HIGH, AND 6.5 FT DIAMETER X 25 FT HIGH. EACH SCRUBBER HAS THREE V-GRATE TYPE TRAYS. THE I.D. FANS ON EACH SCRUBBER EXPERIENCE 3 - 4 IN. W.G. PRESSURE DROP. THE SO2 REMOVAL EFFICIENCY OF THE PROCESS IS 90 PERCENT WITH INLET CONCENTRATION OF 1500 PPM. CHEVRON-TYPE MIST ELIMINATORS ARE USED.

THE SCRUBBERS ARE 316L SS AND THE TRAYS 316 SS. THE INLET DUCTWORK IS CS UP TO THE ECONOMIZER AND THEN 316L SS. THE DOWNSTREAM DUCT IS HEAVY FIBERGLASS AND THE I.D. FANS ARE CS WITH 316L SS LINING ON THE CASING. THE STACK IS FIBERGLASS. THE FLUE GASES ARE NOT REHEATED AND CANNOT BE BYPASSED. THE MIST ELIMINATORS, ORIGINALLY 316 SS, HAVE BEEN LINED WITH PHENOLIC EPOXY RESIN TO COM-

MOBIL OIL CORPORATION: SAN ARDO, CALIFORNIA (CONTINUED)

BAT CORROSION. INADEQUATE MIST REMOVAL HAS ALSO RESULTED IN CORROSION OF THE I.D. FAN IMPELLER, BLADES, AND HUBS, WHICH NEED REPLACEMENT EVERY YEAR. THE HIGH CHLORIDE CONTENT IN THE WASTEWATER IS THE PRIMARY CAUSE OF PITTING OF SS MATERIAL.

OPERATING HISTORY

3RD QUARTER-1978 FOR THIS PERIOD THERE WAS NO MAJOR DOWNTIME REPORTED AS A RESULT OF EQUIPMENT OR PROCESS FAILURE. RELIABILITY WAS ESTIMATED AT ABOUT 90%. A BECKMAN PH CONTROL UNIT WAS INSTALLED ON A SCRUBBING UNIT CONTROLLING EMISSIONS FROM FIVE STEAM GENERATORS.

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	NEKOOSA PAPERS, INC.
INSTALLATION LOCATION	ASHDOWN, ARKANSAS
SOURCE CHARACTERISTICS	COAL (1% - 1.5% SULFUR)
SOURCE RATING	211,000 SCFM (TOTAL - 1 BOILER)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	1
SOURCE CAPACITY	105 MW (EQUIVALENT); DESIGN - 500,000 LB/HR STEAM
CONTROL SYSTEM VENDOR	AIRPOL INDUSTRIES
CONTROL PROCESS	CAUSTIC SCRUBBING
NEW / RETROFIT	NEW
START-UP DATE	FEBRUARY, 1976
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	90+% (600 PPM @ INLET)
PARTICULATE REMOVAL EFFICIENCY	98% - 99% (1.42 GR/SCF AT INLET)
WATER MAKE-UP	OPEN LOOP
SLUDGE OR BY-PRODUCT DISPOSAL	ALKALINE SULFITE/BISULFITE RECYCLED TO PULP PROCESS SO2 RECOVERED FROM SODIUM SULFITE/SULFATE LIQUOR AND RECYCLED TO PULPING PROCESS.
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE NEKOOSA-EDWARDS PAPER PULP MILL IN ASHDOWN, ARKANSAS HAS TWO AIRPOL SCRUBBERS ON A 105-MW EQUIVALENT STEAM BOILER FIRED WITH COAL OR FUEL OIL. THE VENTURI SCRUBBERS ARE DESIGNED TO REMOVE BOTH SULFUR DIOXIDE AND PARTICULATES. THE INTENT OF NEKOOSA-EDWARDS WAS TO MAKE, FROM THE SCRUBBER EFFLUENT, SALTCAKE WHICH WOULD BE USED AT THE MILL. THE COAL HAS 1 - 1.5% SULFUR AND A HEATING VALUE OF 12,000 BTU/LB. IT IS BURNED AT A RATE OF 27 TONS/HR.

THE SCRUBBER HANDLES 325,000 ACFM AT 355 DEGREES F. SCRUBBER INLET SO2 CONCENTRATION IS TYPICALLY 600 PPM WITH A PARTICULATE LOADING OF 1.42 GR/SCFM. RECIRCULATED WATER IS BLED OFF AT 150 - 250 GPM. REAGENT MAKE-UP AMOUNTS TO 12 LB/MIN OF SODIUM HYDROXIDE. SCRUBBER UNDERFLOW CONSISTS OF FLYASH AND A SOLUTION OF SODIUM SULFITE/SULFATE. THE ASH SLURRY GOES TO A SETTLING POND.

THE PREDOMINANT DIFFICULTIES WITH THE FGD SYSTEM HAVE BEEN TWO-FOLD. FIRST, THE PLANT HAS BEEN UNABLE TO DEVELOP AN ADEQUATE PH CONTROL MECHANISM. THE PH CONTROL SYSTEM MONITORS THE AMOUNT OF CAUSTIC AGENT, I.E., SODIUM HYDROXIDE, WHICH GOES INTO THE RECYCLE TANK, KEEPING THE PH OF THE SCRUBBER SOLUTION AT A NONCORROSIVE LEVEL. THE PLANT HAS BEEN PLAGUED WITH PROBLEMS IN OPERATING THE PH CONTROL SYSTEM AND HAS SUFFERED A GREAT DEAL OF CORROSION. THE SECOND PROBLEM CONCERNS THE CHEMICAL REGENERATION PORTION OF THE SYSTEM. THE INTENT OF THE PLANT WAS TO SEPARATE

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

NEKOOSA PAPERS, INC.; ASHDOWN, ARKANSAS (CONTINUED)

THE FLY ASH FROM THE SCRUBBER LIQUID AND TAKE THE SCRUBBER LIQUID THROUGH A SERIES OF EVAPORATORS WHERE SODIUM SULFATE, I.E., SALTCAKE, WOULD BE GENERATED. THE PLANT HAS BEEN UNABLE TO OPERATE THE FLY ASH SEPARATION SYSTEM PROPERLY, AND THERE IS NOT ENOUGH EVAPORATION CAPACITY FOR THE PLANT TO PROCESS THE SCRUBBER EFFLUENT AT FULL OPERATIONAL CAPACITY.

IN SPITE OF THE OPERATIONAL PROBLEMS, THE SULFUR DIOXIDE AND PARTICULATE REMOVAL EFFICIENCIES OF THE FGD SYSTEM ARE 90 AND 99 PERCENT, RESPECTIVELY, ACCORDING TO THE PLANT ENGINEER. THE WASTE PRODUCT FROM THE SCRUBBER IS NOT RECYCLED, AT PRESENT, AND IS PUMPED TO THE WASTEWATER TREATMENT PLANT. CLEANED WASTEWATER IS RETURNED TO THE RIVER.

UPON STARTUP, PROBLEMS OCCURRED WITH THE PIPING AND VALVES WHICH WERE CONSTRUCTED OF CARBON STEEL. THE CARBON STEEL SYSTEM WAS REMOVED AND REPLACED WITH STAINLESS STEEL VALVES AND PIPING. SOME PIPING LEAKS OCCURRED AND WERE REWELDED. SOME CORROSION OF DUCT DAMPERS OCCURED AND WERE RELIEVED BY ADJUSTING THE PH OF THE SCRUBBING LIQUOR. THE PH IS MAINTAINED BETWEEN 5.5 - 6.0.

THE SCRUBBER SYSTEM OPERATES WITHOUT REHEAT, EXHAUSTING TO A FIBERGLASS COATED STACK. PARTICULATES ARE CONTROLLED WITH CYCLONES AND TWO VARIABLE THROAT VENTURI SCRUBBERS WITH AN AVERAGE PRESSURE DROP OF 14 - 16 IN. W.G.

OPERATING HISTORY

3RD QUARTER-1977 NO MAJOR PROBLEMS WERE REPORTED. CORROSION PROBLEMS STILL EXIST AND PH CONTROL IS STILL A PROBLEM. FLOW METERS ARE BEING INSTALLED TO MONITOR SCRUBBER WATER.

4TH QUARTER-1977 TWO FLOW METERS WERE INSTALLED ON EACH SCRUBBER, ONE AT THE THROAT INLET OF THE VENTURI AND ONE AT THE THROAT. THE PLANT REPORTED THAT PH CONTROL WAS STILL A PROBLEM. SOME PROBLEMS WERE BEING ENCOUNTERED WITH THE PH PROBES DUE TO THE CONSTANT FLOW OF LARGE AMOUNTS OF SOLIDS, AND SOLIDS DEPOSITS ON THE PROBES.

2ND QUARTER-1978 NO MAJOR PROBLEMS OCCURRED DURING THE REPORT PERIOD. IN JUNE A PARTICULATE COMPLIANCE TEST WAS RUN. PARTICULATE EMISSIONS WERE 0.05 LB/MM BTU AGAINST THE 0.1 LB/MM BTU REGULATION. CAUSTIC SCRUBBING SOLUTION IS CYCLED TO THE SCRUBBER FROM THE PULP BLEACH PLANT AT 400 GPM. THE BOILER OPERATED 2153 HOURS AT 40% TO 60% CAPACITY. DURING THAT PERIOD THE SCRUBBER DEMONSTRATED 100% OPERABILITY.

3RD QUARTER-1978 DURING THIS REPORT PERIOD THE ONLY PROBLEM THAT WAS REPORTED WAS A RECYCLE PUMP FAILURE CAUSING ONE SCRUBBER TO BE DOWN FOR APPROXIMATELY 1.5 DAYS. HOWEVER, DUE TO THE PARALLEL ARRANGEMENT OF THE SCRUBBING TRAINS AND LOW OPERATING LEVEL OF THE BOILER (40 - 60%), THE TOTAL FLUE GAS FLOW WAS ROUTED THROUGH THE REMAINING SCRUBBER TRAIN. THE BOILER WAS REPORTED TO OPERATE 24 HOURS PER DAY DURING THIS PERIOD.

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	RICKENBACKER AIR FORCE BASE
INSTALLATION LOCATION	COLUMBUS, OHIO
SOURCE CHARACTERISTICS	COAL (3.6% SULFUR)
SOURCE RATING	55,000 SCFM (TOTAL - 7 BOILERS) 277,000 LB/HR STEAM
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	7
SOURCE CAPACITY	27 MW (EQUIVALENT)
CONTROL SYSTEM VENDOR	RESEARCH-COTTRELL/BAHCO
CONTROL PROCESS	LIMESTONE SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	MARCH, 1976
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	90%+ (DESIGN) ACTUAL REMOVAL IS NOW LOWER DUE TO EASING OF REGULATIONS.
PARTICULATE REMOVAL EFFICIENCY	98%
WATER MAKE-UP	OPEN LOOP - 2.5 GPM/MW (MAX)
SLUDGE OR BY-PRODUCT DISPOSAL	NON-FIXATED SLURRY TO LINED POND UNSTABILIZED CASO3/SO4 SLUDGE TO LINED POND
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

ON MARCH 11, 1976 THE FIRST U.S. INSTALLATION OF THE SWEDISH BAHCO SULFUR DIOXIDE REMOVAL SYSTEM WAS PLACED IN SERVICE AT RICKENBACKER AIR FORCE BASE IN COLUMBUS, OHIO. THE SYSTEM, MANUFACTURED BY A.B. BAHCO VENTILATION OF ENKOPING, SWEDEN, DISTRIBUTED EXCLUSIVELY IN THE UNITED STATES BY RESEARCH/COTTRELL, WAS ORIGINALLY INSTALLED AT RICKENBACKER TO HANDLE THE FLUE GAS FROM SEVEN 31 MM BTU/HR STOKER-TYPE COAL FIRED BOILERS INSTALLED BETWEEN 1954 AND 1956. IN JUNE 1977, A NEW 60 MM BTU/HR BOILER CAME INTO SERVICE. THIS UNIT REPLACED 2 OF THE OLDER BOILERS, AND A THIRD WAS PLACED ON STAND-BY. THE BOILERS ALL FIRE A HIGH SULFUR (3.6%) COAL.

THE RICKENBACKER EMISSION CONTROL SYSTEM CONSISTS ESSENTIALLY OF A MECHANICAL COLLECTOR, 2-STAGE BAHCO SCRUBBER TOWER, LIMESTONE STORAGE AND HANDLING SYSTEM, CLARIFIER, BOOSTER FAN AND ASSOCIATED DUCT-WORK, PUMPS, CONTROLS, AND A SLUDGE DISPOSAL POND.

SOLID PARTICULATE AND SULFUR DIOXIDE-LADEN FLUE GAS TAKEN FROM EACH OF THE EXISTING SIX STACKS IS FED THROUGH A COMMON HEADER AND INTO A MECHANICAL COLLECTOR WHERE PRIMARY PARTICULATE REMOVAL TAKES PLACE. THE MECHANICAL COLLECTOR HAS A DESIGN REMOVAL EFFICIENCY OF 70 PERCENT AND WAS INSTALLED PRIMARILY TO REDUCE FAN WEAR. THE PARTIALLY CLEANED GAS THEN FLOWS INTO THE BAHCO TOWER WHERE ADDITIONAL PARTICULATE AND PRIMARY SULFUR DIOXIDE REMOVAL TAKES PLACE.

SECTION 4 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

WICKENBACKER AIR FORCE BASE: COLUMBUS, OHIO (CONTINUED)

THE BACHO SCRUBBING VESSEL IS A VERTICAL TOWER CONSISTING OF TWO SCRUBBING STAGES. GAS FLOWS THROUGH THE TOWER WHERE IT IS CONTACTED WITH A LIMESTONE SLURRY. AFTER PASSING THROUGH THE FIRST SCRUBBING STAGE, ENTRAINED MOISTURE IS REMOVED BY A CYCLONIC TYPE MIST ELIMINATOR. THE GAS THEN PASSES THROUGH A SECOND SCRUBBING STAGE AND A SECOND CYCLONIC MIST ELIMINATOR. THE CLEANED GAS IS DISCHARGED TO THE ATMOSPHERE THROUGH A STUB STACK ATOP THE ABSORBER TOWER.

FINE MESH LIMESTONE IS EMPLOYED AS THE REAGENT IN THE SCRUBBING SYSTEM. THE SCRUBBING SLURRY IS PUMPED TO THE ABSORBER WHERE IT IS CONTACTED WITH THE FLUE GAS IN A COUNTERCURRENT FASHION.

THE SPENT SCRUBBING SOLUTION IS DISCHARGED TO THE THICKENER WHERE THE WASTE SOLIDS SETTLE OUT. THICKENER OVERFLOW IS RETURNED TO THE MIX/HOLD TANK. THICKENER UNDERFLOW IS DISCHARGED TO A 5-ACRE HYPALON-LINED DISPOSAL POND. THIS POND IS LOCATED APPROXIMATELY 400 FEET FROM THE ABSORBER TOWER. CLEAR WATER FROM THE POND IS RETURNED TO THE PROCESS AS MAKE-UP WATER IN THE SLURRY TANK.

REFER TO FIGURE 14-12 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

MAR. 76 THROUGH OCT. 76   THE INITIAL OPERATION PROCEEDED IN AN OPEN-WATER-LOOP MODE BECAUSE THE THICKENER WAS NOT YET COMPLETELY INSTALLED. SULFUR DIOXIDE INLET CONCENTRATIONS WERE IN THE 1800 TO 2000 PPM RANGE. HIGH OXYGEN CONCENTRATIONS ALSO EXISTED IN THE FLUE GAS BECAUSE THESE OLDER, INEFFICIENT BOILERS OPERATE AT 150 TO 160 PERCENT EXCESS AIR RATES. SULFUR DIOXIDE REMOVAL EFFICIENCY WAS IN THE LOW 90 PERCENT PLUS RANGE. EARLY PROBLEMS WERE PRIMARILY OF A MECHANICAL NATURE USUALLY ASSOCIATED WITH START-UP. THE MAJOR START-UP PROBLEMS WERE AS FOLLOWS:

1. ELECTRICAL CIRCUITS AND SYSTEM CONTROL PANEL.
2. PUMP MALFUNCTION-SPARE PARTS SHIPMENT DELAY.
3. SEDIMENTATION BUILDUP IN THE SCRUBBER VESSEL (THIS WAS DUE PRIMARILY TO OPERATION AT HIGHER THAN DESIGN SOLIDS CONCENTRATION IN THE SCRUBBING SOLUTION BECAUSE THE THICKENER WAS NOT YET IN SERVICE PLUS GRIT GETTING THROUGH THE LIME SLAKER GRIT REMOVAL STEP).
4. FAMILIARIZATION OF THE OPERATING STAFF WITH THE MECHANICS OF THE PROCESS.
5. I.D. BOOSTER FAN PROBLEMS. ADDITIONAL BRACING, AND EPOXY GROUTING WAS REQUIRED TO STOP THE ELEVATED FAN CONCRETE SUPPORT FROM VIBRATING WHILE THE FAN WAS OPERATING.

NOV. 76 THROUGH JUN. 77   DOWNTIME WAS LESS THAN 5%. OPERATING PROBLEMS WERE MECHANICAL- AND CONTROL- RATHER THAN PROCESS-RELATED. FAN-RELATED PROBLEMS ACCOUNTED FOR OVER 75% OF THE ACTUAL DOWN-TIME. THIS RESULTED FROM EXCESSIVE FAN VIBRATIONS CAUSED BY BEARING, SUPPORT, AND INSTRUMENTATION DIFFICULTIES. IN APRIL 1977, THE FAN WHEEL DEVELOPED A CRACK IN THE RIM ATTRIBUTED TO FATIGUE FROM RESONANT VIBRATION. THE FAN WAS SENT BACK TO THE MANUFACTURER, AMERICAN STANDARD, WHO MADE THE REQUIRED MODIFICATIONS. THE ORIGINAL FAN WAS RADIAL BLADE WITH RIMS, AND A MAJOR MODIFI-

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

RICKENBACKER AIR FORCE BASE: COLUMBUS, OHIO (CONTINUED)

CATION WAS CHOPPING THE RIMS OFF, THEREBY REDUCING THE DIAMETER. THE FAN WAS RETURNED IN EARLY MAY AND THE VIBRATION PROBLEM WAS SOLVED. OTHER OPERATIONS WERE RELATIVELY PROBLEM-FREE. THERE WERE NO CORROSION, EROSION, SCALING, OR PLUGGING PROBLEMS. THE SYSTEM BEGAN RUNNING ON LIMESTONE IN APRIL, AS PART OF THE EPA TEST PROGRAM. LIMESTONE PERFORMED WELL, YIELDING ADEQUATE REMOVAL.
ON JUNE 3RD, THE STEAM PLANT WAS SHUTDOWN FOR THE TIE-IN OF THE NEW NO. 8 BOILER. TIE IN WAS COMPLETED IN JUNE.

AUG. 77 THE ARMS BROKE OFF IN THE 25-FOOT DIAMETER THICKENER TANK, CAUSING A 30 DAY DOWNTIME.
SEP. 77 A MAKE-UP WATER BOOSTER PUMP HAD TO BE REPLACED.
OCT. 77 THE MOTOR DRIVE ON THE SLAKER BELT HAD TO BE REPAIRED. ALTHOUGH THE SLAKER IS NO LONGER USED WITH THE LIMESTONE REAGENT, THE BELT IS USED TO CONVEY THE LIMESTONE TO THE DISSOLVING TANK.

1ST QUARTER-1978 IT WAS DISCOVERED THAT WITH A STOICHIOMETRIC RATIO OF 0.75 THE REQUIRED DEGREE OF SO2 REMOVAL CAN BE ACHIEVED. THE CURRENT REGULATION LIMITS EMISSIONS TO 2.2 LBS/MM BTU HEAT INPUT. DURING THE JANUARY BLIZZARD, SOME FREEZE-UP PROBLEMS WERE ENCOUNTERED.
DURING JANUARY THE BOILERS OPERATED 744 HOURS AND THE FGD SYSTEM OPERATED 596 HOURS YIELDING OPERABILITY AND AVAILABILITY INDEX VALUES OF 80%. ALL DOWNTIME WAS ATTRIBUTABLE TO FREEZE-UPS DURING BLIZZARD CONDITIONS. DURING FEBRUARY, THE BOILERS OPERATED 672 HOURS AND THE CONTROL SYSTEM OPERATED 168 HOURS. HOWEVER THE FGD SYSTEM WAS AVAILABLE 551 HOURS. THEREFORE THE OPERABILITY INDEX WAS 25% WHILE THE AVAILABILITY WAS 82%. THE ABSORBER LINES WERE THAWED OUT FEBRUARY 6, BUT DURING FEBRUARY, THE GOVERNOR OF OHIO TEMPORARILY SHELVED POLLUTION CONTROL REGULATIONS. THEREFORE THE FGD SYSTEM WAS NOT OPERATED ALTHOUGH IT WAS AVAILABLE FOR OPERATION. THE SYSTEM WAS SHUTDOWN ON FEBRUARY 13 AND DID NOT OPERATE DURING MARCH.

2ND QUARTER-1978 SYSTEM WAS RESTARTED APRIL 10 AND WAS REPORTED TO HAVE RUN WITH A 100% OPERABILITY INDEX VALUE FOR THE REMAINING PERIOD. PLANT REPORTED THAT ALL PREVIOUS PROBLEMS HAVE BEEN CORRECTED. DURING THE LAST PORTION OF THE 2ND QUARTER THE BOILER LOAD DROPPED TO ITS SUMMER LEVEL, ABOUT 30 MM BTU/HR, AS OPPOSED TO THE MAXIMUM COLD SEASON LOAD OF 150 MM BTU/HR.

3RD QUARTER-1978 THE SYSTEM OPERATED WITH AN AVAILABILITY INDEX OF OVER 99.5% FOR THE PERIOD. THE SCRUBBER WAS CLEANED AND INSPECTED DURING A 5-DAY BOILER MAINTENANCE OUTAGE AND FOUND TO BE RELATIVELY FREE OF CORROSION AND SCALING. THE SYSTEM WAS OBTAINING ABOUT 75% SO2 REMOVAL, WHICH WAS SUFFICIENT TO MEET THE REGULATION. WHILE THE BOILER IS OPERATING AT ITS REDUCED SUMMER LOAD, FRESH MAKE-UP AIR IS BEING MIXED WITH THE FLUE GAS ENTERING THE F.D. FAN TO MAINTAIN FULL GAS PRESSURE AND VELOCITY THROUGH THE ABSORBER.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	SHELLER GLOBE CORP.
INSTALLATION LOCATION	NORFOLK, VIRGINIA
SOURCE CHARACTERISTICS	COAL (< 1.0% SULFUR)
SOURCE RATING	8,000 SCFM (TOTAL - 1 BOILER)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	1
SOURCE CAPACITY	4 MW (EQUIVALENT); TOTAL - 1 BOILER
CONTROL SYSTEM VENDOR	W.W. SLY MANUFACTURING CO.
CONTROL PROCESS	SODIUM HYDROXIDE SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	1975
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	NOT DETERMINED
PARTICULATE REMOVAL EFFICIENCY	NOT DETERMINED
SLUDGE OR BY-PRODUCT DISPOSAL	OVERFLOW TO SEWER/SLUDGE TO LANDFILL
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

IN NORFOLK, VIRGINIA, SHELLER GLOBE CORPORATION OPERATES THE MITCHELL SMITH DIVISION PLANT, WHERE THE PRIMARY PRODUCT IS CORK RUBBER GASKET MATERIAL. PROCESS (AUTOCLAVE) AND HEATING STEAM ARE SUPPLIED BY A BOILER RATED AT 350 BOILER HP (ABOUT 3.5 MW EQUIVALENT). STEAM CONDITIONS ARE 125 PSI AT 325 F. THE BOILER WAS ORIGINALLY ERECTED IN 1939, BUT UNDERWENT A COMPLETE OVERHAUL IN 1977. BOILER TUBES, REFRACTORY BRICK, GRATE, AND SOOT BLOWERS WERE REPLACED DURING THE OVERHAUL. THE BOILER FIRES COAL SUPPLIED BY GENERAL COAL - NOMINAL SIZE IS 1.25 X 0.25 INCHES. COAL CHARACTERISTICS ARE AS FOLLOWS: HHV=13,200 BTU/LB, ASH=6%, AND SULFUR IS LESS THAN 1%.

THE EMISSIONS CONTROL SYSTEM AT SHELLER GLOBE CONSISTS OF A W.W. SLY SINGLE-STAGE IMPINJET SCRUBBER (#170) WHICH REMOVES PARTICULATE AND SO2 FROM THE FLUE GAS. THE SYSTEM USES A NAOH MAKE-UP PRIMARILY FOR CORROSION CONTROL BUT SO2 CONTROL IS AN ADDITIONAL BENEFIT. RECYCLE TANK SUPERNATANT IS PH NEUTRALIZED AND IS DISCHARGED TO CITY SEWERS WHILE FLY ASH AND SEDIMENT ARE SETTLED, SCRAPED OUT AND HAULED TO A SANITARY LANDFILL.

THE SCRUBBER MODULE IS CONSTRUCTED OF STAINLESS STEEL (19,200 CFM DESIGN MAX.). THE RECYCLE TANK IS CONSTRUCTED OF UNLINED STEEL (20 FT X 10 FT X 8 FT) AND THE PIPING IS OF PVC.

UPON INITIAL STARTUP NO CAUSTIC WAS INTRODUCED TO THE SYSTEM AND WITHIN A FEW MONTHS THE INTERNALS OF THE MODULE AND THE STEEL PIPING SYSTEM WERE CORRODED BEYOND USE. THIS NECESSITATED REPLACEMENT OF THE INTERNALS, SUBSTITUTION OF STEEL PIPE WITH PVC, AND ADDITION OF NAOH TO THE SCRUBBING LIQUOR.

CHEMICALS ARE PURCHASED FROM THE CHEMICAL TREATMENT CO. WHO ALSO OPERATE THE SCRUBBING SYSTEM.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

SHELLER GLOBE CORP.; NORFOLK, VIRGINIA (CONTINUED)

SCRUBBING SYSTEM.

OPERATING HISTORY

2ND QUARTER-1978 DURING THE REPORT PERIOD THE UNIT UNDERWENT A VIRGINIA EPA CERTIFICATION INSPECTION, AND WAS FOUND TO BE IN COMPLIANCE. NO SCRUBBER-RELATED PROBLEMS HAVE OCCURRED.

3RD QUARTER-1978 BOILER OPERATION WAS ESTIMATED TO BE AT 60% CAPACITY 24 HRS PER DAY 6 DAYS PER WEEK. NO SCRUBBER-RELATED PROBLEMS HAVE BEEN REPORTED. PLANT PERSONNEL ARE CONSIDERING REPLACEMENT OF THE PRESENT SYSTEM DUE TO WEAR ON THE EQUIPMENT.

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	ST. REGIS PAPER CO.
INSTALLATION LOCATION	CANTONMENT, FLORIDA
SOURCE CHARACTERISTICS	BARK,OIL/GAS (< 1.0% SULFUR)
SOURCE RATING	115,000 SCFM (1 BOILER)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	1
SOURCE CAPACITY	57 MW (EQUIVALENT); DESIGN - 300,000 LB/HR STEAM
CONTROL SYSTEM VENDOR	AIRPOL INDUSTRIES
CONTROL PROCESS	CAUSTIC SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	1973
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	80% - 90%
PARTICULATE REMOVAL EFFICIENCY	94.5% (400 LB/HR AT INLET)
WATER MAKE-UP	OPEN LOOP; 200 GPM-250 GPM SCRUBBING LIQUOR FEED
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT
	EFFLUENT IS TREATED IN AN ON-SITE SEWAGE TREATMENT PLANT
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE SCRUBBER SYSTEM AT ST. REGIS PAPER LOCATED AT CANTONMENT, FLORIDA WAS MANUFACTURED BY AIRPOL. THE UNIT IS CONSTRUCTED OF 316L STAINLESS STEEL AND HANDLES A TOTAL FLUE GAS VOLUME OF 175,000 ACFM. PARTICULATES ARE CONTROLLED WITH CYCLONES PRECEEDING THE SCRUBBER. SCRUBBER PRESSURE DROP IS APPROXIMATELY 10 IN. W.G. WITH 80-90% SULFUR DIOXIDE REMOVAL EFFICIENCY. THE SCRUBBER IS FOLLOWED BY A CHEVRON-TYPE MIST ELIMINATOR.

THE BOILER IS RATED AT 57 MW EQUIVALENT AND PRODUCES 300,000 LBS/HR STEAM. THE TYPICAL SULFUR CONTENT OF THE FUEL (OIL OR BARK, NATURAL GAS) IS LESS THAN 1%. THE HEATING VALUES OF THE FUELS ARE AS FOLLOWS; BARK @ 50% MOISTURE IS 4030 BTU/LB, THE OIL IS 6,000,000 BTU/BARREL AND THE GAS IS 1400 BTU PER FT3.

SCRUBBER UNDERFLOW CONSISTS OF ASH AND A SODIUM SULFITE/SULFATE SOLUTION. BLOWDOWN FROM THE SCRUBBER OCCURS EVERY FEW MINUTES. TO MAINTAIN THE RECIRCULATION TANK AT A CONSTANT VOLUME, A SOLENOID IS USED WHICH AUTOMATICALLY OPENS A VALVE AND INTRODUCES MAKE-UP WATER WHEN THE LEVEL OF THE LIQUOR DROPS TO A CERTAIN POINT. THE TANK HAS A CAPACITY OF 4000-5000 GALLONS AND IS MADE OF 304 STAINLESS STEEL. A BLEED-OFF STREAM FROM THE RECIRCULATION TANK IS SENT TO AN ON-SITE SEWAGE TREATMENT PLANT WHERE IT RECEIVES PRIMARY CLARIFICATION AND AERATION/STABILIZATION FOR REDUCED BOD. CHARGED TO AN ON-SITE SEWAGE TREATMENT PLANT WHERE IT RECEIVES PRIMARY CLARIFICATION AND AERATION STABILIZATION FOR REDUCTION OF BIOLOGICAL OXYGEN DEMAND(BOD).

ST. REGIS PAPER CO.; CANTONMENT, FLORIDA (CONTINUED)

REFER TO FIGURE 14-14 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

3RD QUARTER-1977 WOOD FIBERS FROM BARK WERE CLOGGING SEPARATORS AND CONTROL VALVES. INSPECTION WAS MADE AND SOLUTION TO PROBLEM WAS BEING INVESTIGATED.

4TH QUARTER-1977 AFTER INVESTIGATION OF THE CLOGGING PROBLEM IT WAS DECIDED TO CHANGE THE MAKE-UP WATER SOURCE. WATER IS NOW OBTAINED FROM A CLEANER PORTION OF THE PROCESS LOOP. PLANT REPORTS SATISFACTORY OPERATIONS WITH NO OTHER MAJOR PROBLEMS.

2ND QUARTER-1978 PLUGGING DUE TO FIBERS IN THE SCRUBBER FEEDWATER REMAINED TO BE AN UNSOLVED PROBLEM DURING THE REPORT PERIOD. PLANT HAD NOT YET CHANGED THE SCRUBBER LIQUOR FEED SOURCE. IN THE JANUARY THROUGH MAY PERIOD, THE BOILER OPERATED 3473 HOURS. SCRUBBER RELIABILITY INDEX WAS NEAR 100%. THE PLANT INDICATED THAT THIS REPORT HAD BEEN REPORTING TOO HIGH A SULFUR CONTENT IN THE FUEL (2-3 %), AS COMPARED TO THE CORRECT VALUE OF LESS THAN 1%.

3RD QUARTER-1978 THE SCRUBBER LIQUOR FEED SOURCE HAS NOT BEEN CHANGED, HENCE, PLUGGING STILL REMAINS AN UNSOLVED PROBLEM. HOWEVER, THE PLANT REPORTED GOOD OPERATION FOR THIS QUARTER. FROM JANUARY THROUGH JULY, THE BOILER BURNED BARK FOR 4223 HOURS AND GAS AND OIL FOR 665 HOURS. THE TOTAL TIME THE BOILER WAS IN OPERATION WAS 4888 HOURS. THE SCRUBBER EXHIBTED 100% AVAILABILITY.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	TEXACO INCORPORATED
INSTALLATION LOCATION	SAN ARDO, CALIFORNIA
SOURCE CHARACTERISTICS	OIL (1.7% SULFUR)
SOURCE RATING	366,000 SCFM (TOTAL - 24 BOILERS) 26,000 ACFM @ 600F, FOR EACH OF 22 FGD SYSTEMS 80,000 ACFM @ 600F, FOR EACH OF 2 FGD SYSTEMS
NUMBER OF SEPARATE FGD UNITS	24
NUMBER OF BOILERS BEING CONTROLLED	24
SOURCE CAPACITY	183 MW (EQUIVALENT); 1460 MM BTU/HR; TOTAL- 24 BOILERS
CONTROL SYSTEM VENDOR	CEILCOTE
CONTROL PROCESS	SODIUM HYDROXIDE SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	NOVEMBER, 1973
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	73% (1000 PPM @ INLET)
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT HALF OF THE SCRUBBER UNDERFLOW IS TREATED AND RECYCLED AS BOILER FEEDWATER; THE OTHER HALF GOES TO WASTEWATER DISPOSAL WELLS.
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

TEXACO USES SEVERAL OIL-FIRED BOILERS AT THE SAN ARDO, CALIFORNIA SITE. THE STEAM IS INJECTED INTO OIL WELLS TO FACILITATE OIL FLOW. THERE ARE TWO DIFFERENT SIZES OF THE BOILERS: 2 @ 180 MM BTU/HR, AND 31 @ 50 MM BTU/HR. THE FUEL OIL HAS A TYPICAL SULFUR CONTENT OF 1.7%.

THE FLUE GASES (80,000 ACFM FROM THE LARGER GENERATORS AND 26,000 ACFM FROM THE SMALLER GENERATORS @ 600 F) ARE SCRUBBED BY AN FGD SYSTEM SUPPLIED BY CEILCOTE COMPANY IN NOVEMBER 1973. EACH BOILER IS FOLLOWED BY A QUENCHING CHAMBER AND A SCRUBBER. THE SCRUBBERS, WHICH ARE HORIZONTAL TOWERS PACKED WITH 2 IN. TELLERITE PACKINGS, ARE OF SIZES: 15 FT x 15 FT x 20 FT (2 UNITS), AND 15 FT X 15 FT X 9.5 FT (22 UNITS). THE OTHER NINE UNITS ARE GOING TO BE CONTROLLED BY DUCON UNITS AS DISCUSSED IN SECTION 10 OF THIS REPORT. THE GAS FLOWS ACROSS THE HORIZONTAL SCRUBBER WHEREAS THE LIQUID IS SPRAYED PRIMARILY IN A CROSS-CURRENT MODE. THE ABSORBER SECTION IS FOLLOWED BY A SHORTER PACKED DEPTH WHICH SERVES AS A MIST ELIMINATOR (M-E). THE SCRUBBING LIQUOR IS A MIXTURE OF NATURAL WATER AND 50% NAOH SOLUTION. THE TYPICAL LIQUID MASS FLUX VALUES ARE 2000 - 3000 LBS/HR FT2. A L/G RATIO OF 18 GAL/1000 SCF IS USED AND PH AT THE INLET IS 8.0. THE FLUE GASES ENTER THE QUENCHERS AT 600 F WITH 1000 PPM SO2 AND LEAVE THE M-E'S AT 160 F WITH 270 PPM SO2. THE SPENT LIQUOR IS SPLIT INTO TWO STREAMS, ONE RECYCLED AS BOILER FEED WATER AFTER REMOVING FLYASH AND

TEXACO INCORPORATED; SAN ARDO, CALIFORNIA (CONTINUED)

SOFTENING, THE OTHER IS DISPOSED OF IN WASTE-WATER DISPOSAL WELLS.

THE ABSORBER MODULES, DOWNSTREAM DUCTWORK, STACK AND THE I.D. FAN ARE MADE OF FRP, WHEREAS THE PACKING IS POLYPROPYLENE. THE QUENCHER SECTION IS 316 SS, WHEREAS THE SPENT LIQUOR PIPING, CAUSTIC TANKS, AND THE CAUSTIC FEED LINES ARE MILD STEEL.

REFER TO FIGURE 14-15 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

THE MAJOR OPERATIONAL PROBLEM AREAS ARE:

1. THE QUENCHER SECTION HAS SUFFERED SEVERE CORROSION DUE TO ACID ATTACK.
2. FRP LINER DETERIORATES DUE TO MECHANICAL ABRASION DURING CLEANING OPERATIONS. IT NEEDS OCCASIONAL RESURFACING.
3. THE PACKED BEDS ARE FREQUENTLY PLUGGED BY FLYASH. THE OIL IN THE NATURAL LIQUOR HAS CAUSED FOULING OF THE PACKED BEDS.
4. OCCASIONAL OVERINJECTION OF CAUSTIC HAS RESULTED IN PLUGGING OF SPRAY NOZZLES BY SCALES.

1ST QUARTER-1978 DUE TO THE LOW SO2 REMOVAL AND HIGH MAINTENANCE COST OF THE ABOVE DESIGN, TEXACO HAS UNDERTAKEN A TEST PROGRAM WHICH, IF SUCCESFUL, WILL PHASE OUT THE PRESENT SCRUBBERS BY THE END OF 1979. FOR MORE INFORMATION ON THE PROGRAM SEE THE OTHER TEXACO, SAN ARDO BACKGROUND INFORMATION ENTRY IN SECTION 10 OF THIS REPORT.

2ND QUARTER-1978 THE AVAILABILITY OF EACH FGD SYSTEM WAS APPROXIMATELY 94%. ON AN AVERAGE, ONE SYSTEM WAS SHUTDOWN TWO DAYS A MONTH FOR MAINTENANCE.

3RD QUARTER-1978 THERE WAS NO MAJOR DOWNTIME DUE TO EQUIPMENT OR PROCESS FAILURE. THE SCRUBBERS WERE DOWN FOR SCHEDULED MAINTENANCE FOR ABOUT 8 HOURS PER MONTH REQUIRING ABOUT 24-MAN-HOURS PER UNIT. GENERALLY DURING THIS REGULAR MAINTENANCE PERIOD THE PACKING IS REPLACED AND THE INTERNALS INSPECTED AND CLEANED. TEXACO IS CONSIDERING CONVERTING FROM NAOH TO NA2CO3 AS THE REAGENT. NO TIMETABLE HAS BEEN ESTABLISHED FOR SUCH A TRANSITION.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	TEXASGULF
INSTALLATION LOCATION	GRANGER, WYOMING
SOURCE CHARACTERISITCS	OIL (1.1% SULFUR)
SOURCE RATING	140,000 SCFM (TOTAL - 2 BOILERS) 600,000 LB/HR STEAM (TOTAL)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	70 MW (EQUIVALENT); TOTAL - 2 BOILERS
CONTROL SYSTEM VENDOR	SWEMCO INC.
CONTROL PROCESS	SODIUM CARBONATE SCRUBBING
NEW / RETROFIT	NEW
START-UP DATE	SEPTEMBER, 1976
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	90% (680 PPM @ INLET)
PARTICULATE REMOVAL EFFICIENCY	99.3% (HOT-SIDE ESP W/PRECEDING MECHANICAL COLLECTOR)
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

TEXASGULF INC. HAS BEEN OPERATING A NEW SODA ASH PLANT (1 MM TONS/YR) AT GRANGER, WYOMING, SINCE SEPTEMBER 1976. TWO BOILERS GENERATE A TOTAL OF 600,000 LBS/HR SATURATED STEAM @ 300 PSIG. UNIT EFFICIENCY IS 85% WHEN BURNING WYOMING SUB-BITUMINOUS COAL, WHICH HAS 13.97% MOISTURE, 6.43% ASH, AND 0.75% SULFUR ON AN AS-RECEIVED BASIS. THE HEATING VALUE OF THE COAL IS 10,424 BTU/LB ON AN AS-RECEIVED BASIS. EACH BOILER BURNS APPROXIMATELY 25,000 LB/HR OF THE COAL.

AFTER FLUE GASES LEAVE EACH BOILER, (156,150 ACFM @ 350 F) THEY PASS THROUGH A MECHANICAL COLLECTOR, ESP, ECONOMIZER, AND WET SCRUBBER. (THE ECONOMIZER IS LOCATED AFTER THE PRECIPITATER BECAUSE THE ASH FROM WESTERN COAL IS COLLECTED MORE EFFICIENTLY WHEN THE GAS IS HOT). THE CYCLONE AND ESP TOGETHER HAVE A PARTICULATE REMOVAL EFFICIENCY OF 99.3%. THE SCRUBBING SYSTEMS, WHICH WERE INSTALLED DOWNSTREAM OF THE ECONOMIZER BY SWEMCO INC. ALONG WITH THE NEW PLANT IN SEPTEMBER 1976, CONSISTS OF A QUENCHER, A SIEVE TRAY ABSORBER (15 FT DIA X 20.5 FT HIGH) AND A BYPASS. FLUE GAS IS SPRAY-COOLED FROM 350 F TO 125 F AS IT ENTERS THE QUENCHER AND IS DIRECTED INTO THE CIRCULATING LIQUOR IN THE RESERVOIR. THE GAS BUBBLES UP THROUGH THE LIQUOR, ENTERS THE ADJACENT ABSORBER AND TRAVELS UP THROUGH TWO SIEVE TRAYS. SCRUBBING LIQUOR (7000 GPM TO THE ABSORBER, 300 GPM TO THE QUENCHER) IS RECIRCULATED FROM THE SCRUBBER PUMP TANK WHICH RECEIVES THE SCRUBBER EFFLUENT (1023 GPM). A CONSTANT BLEED-OFF (250 TO 487 LB/MIN) CONTAINING 8% OF SODIUM SALTS IS PURGED TO A HOLDING POND FOR EVAPERATION. A CHEVRON-TYPE MIST ELIMINATOR (M-E) IS USED. THE CLARIFIED MAKEUP WATER (60 TO 93 GPM) IS USED FOR M-E WASHING (15 GPM) AND QUENCHER SPRAY (45 TO 66 GPM). MAKEUP SODA

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

TEXASGULF: GRANGER, WYOMING (CONTINUED)

ASH 30% BY WEIGHT, IS FED FROM A LIQUOR HEAD TANK TO THE SCRUBBER PUMP TANK AT A MINIMUM RATE OF 56 LB/MIN AND MAX. RATE OF 119 LB/MIN.

EACH ABSORBER IS DIVIDED VERTICALLY INTO TWO SECTIONS, ONE OF WHICH HAS A DAMPER AT THE TOP. THIS PERMITS CURTAILMENT OF GAS FLOW THROUGH HALF OF THE UNITS AT LOW LOADS. THE ABSORBER, THEREFORE, CAN OPERATE AT THE DESIGN EFFICIENCY WHEN THE BOILER PRODUCES FROM 25% TO 100% OF ITS RATED OUTPUT. THE ABSORBER BYPASS ALLOWS UP TO 25% OF THE INCOMING HOT FLUE GAS TO BE DIVERTED. TYPICALLY, TEXASGULF USES THE BYPASS TO KEEP THE FLUE GAS IN THE STACK 10 F WARMER THAN THAT AT THE SCRUBBER OUTLET. THE SCRUBBERS ARE MADE OF 316L SS, THE TRAYS ARE UDDEHOLM 904-L, THE PUMP TANKS ARE FRP AND THE STACK (7.5 FT ID X 150 FT HIGH) IS DOUBLE-WALL, INSULATED STEEL TYPE WITH FLAKELINE COATING BY CEILCOTE COMPANY.

REFER TO FIGURE 14-16 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

1ST QUARTER-1978 THE OUTLET DUCTWORK, WHICH WAS CORRODED DUE TO ACID CONDENSATE, WAS TO BE REPLACED. THE SYSTEM OPERATED WITHOUT ANY MAJOR PROBLEMS.

2ND QUARTER-1978 DURING A MAJOR ELECTRICAL TURNAROUND, THE SCRUBBER MODULES WERE CLEANED AND REPAIRED, SLUDGE FROM THE TRAYS WAS REMOVED AND THE OUTLET DUCTWORK WAS REPLACED BY 304 SS. THE SO2 MEASURING INSTRUMENTS WERE BEING UPGRADED BY LEAR SIEGLER, THE SUPPLIER.

3RD QUARTER-1978 DURING THE REPORT PERIOD, THE BOILER AND FGD SYSTEM WERE DOWN TWICE FOR SCHEDULED INSPECTION OUTAGES. DOWNTIME WAS 4 DAYS FOR ONE MODULE AND 2 DAYS FOR THE OTHER. SOME MINOR PLUGGING WAS OBSERVED DURING THE INSPECTION PERIODS.

SECTION 10

DESIGN INFORMATION FOR UNDER CONSTRUCTION FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	BELRIDGE OIL CO.
INSTALLATION LOCATION	MCKITTRICK, CALIFORNIA
SOURCE CHARACTERISTICS	CRUDE OIL (1.1% SULFUR)
SOURCE RATING	12,000 SCFM 24,000 ACFM @ 570 F
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	5 MW (EQUIVALENT), 50 MBTU/HR
CONTROL SYSTEM VENDOR	C-E NATCO
CONTROL PROCESS	SODIUM HYDROXIDE SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	NOVEMBER, 1978
CONTROL SYSTEM STATUS	CONSTRUCTION
SO2 REMOVAL EFFICIENCY	90% (500 PPM SO2 @ INLET)
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

DESIGN INFORMATION FOR UNDER CONSTRUCTION FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	CATERPILLAR TRACTOR CO.
INSTALLATION LOCATION	MAPLETON, ILLINOIS
SOURCE CHARACTERISTICS	COAL (3.2% SULFUR)
SOURCE RATING	157,000 SCFM (TOTAL - 3 BOILERS) 80,000 ACFM @ 350 F, FOR EACH OF 3 FGD SYSTEMS
NUMBER OF SEPARATE FGD UNITS	3
NUMBER OF BOILERS BEING CONTROLLED	3
SOURCE CAPACITY	79 MW (EQUIVALENT); TOTAL - 3 BOILERS
CONTROL SYSTEM VENDOR	FMC ENVIRONMENTAL EQUIPMENT
CONTROL PROCESS	DOUBLE ALKALI (CONCENTRATED)
NEW / RETROFIT	NEW
START-UP DATE	OCTOBER, 1978
CONTROL SYSTEM STATUS	CONSTRUCTION
SO2 REMOVAL EFFICIENCY	90% (2000 PPM @ INLET)
SLUDGE OR BY-PRODUCT DISPOSAL	DEWATERED SLURRY TO LANDFILL 60+% SOLIDS (CASO4) SLUDGE DIRECTLY TO LANDFILL
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

AT THE MAPLETON, ILLINOIS PLANT, CATERPILLAR TRACTOR IS INSTALLING TWO NEW BOILER PLANTS WHICH WILL BE COMPLETED BY THE EARLY 1980'S. PLANS CALL FOR THE ERECTION OF EIGHT BOILERS, EACH RATED AT ABOUT 200,000 LBS/HR STEAM. THE TOTAL STEAM GENERATING CAPACITY WILL BE 1,650,000 LBS/HR STEAM. THREE OF THESE BOILERS WILL BE COMPLETED BY THE 1978-79 HEAT SEASON. TWO MORE WILL COME ON-LINE DURING THE 1979-1980 HEAT SEASON. THE START-UP DATES FOR THE OTHER THREE HAVE NOT YET BEEN DETERMINED. CATERPILLAR HAS AWARDED A CONTRACT TO FMC ENVIRONMENTAL EQUIPMENT TO PROVIDE CONCENTRATED-MODE DUAL ALKALI FGD SYSTEMS FOR ALL EIGHT BOILERS.

THERE ARE TWO CATERPILLAR FACILITIES AT MAPLETON, LOCATED NEXT TO EACH OTHER. THERE WILL BE FOUR BOILERS AT EACH FACILITY. EACH BOILER WILL HAVE A SEPARATE FGD SYSTEM. THE 4 FMC SYSTEMS AT EACH FACILITY WILL SHARE REGENERATION FACILITIES, VACUUM FILTER, AND SLUDGE DISPOSAL. EACH FGD TRAIN WILL BE TREATING APPROXIMATELY 80,000 ACFM @ 350 F.

OPERATING HISTORY

3RD QUARTER-1977 SYSTEM WAS UNDER CONSTRUCTION. START-UP WAS EXPECTED LATE IN THE FALL OF 1977.

4TH QUARTER-1977 CONSTRUCTION DELAYS ON THE STEAM GENERATION SIDE PUSHED PLANT START-UP BACK TO THE FALL OF 1978.

2ND QUARTER-1978 START-UP WAS STILL PLANNED FOR THE 1978-1979 HEATING SEASON. THREE BOILERS AND THEIR INDIVIDUAL FMC FGD SYSTEMS WILL COME ON-LINE AT THAT TIME.

DESIGN INFORMATION FOR UNDER CONSTRUCTION FGD SYSTEMS ON INDUSTRIAL BOILERS

CATERPILLAR TRACTOR CO.: MAPLETON, ILLINOIS (CONTINUED)

3RD QUARTER-1978   CONSTRUCTION WAS NEARING COMPLETION. SPECIAL MODIFICATIONS WERE BEING MADE WHICH WERE DELAYING START-UP. EXPERIENCE GAINED AT MOSSVILLE IS BEING APPLIED TO MAPLETON SINCE THE SYSTEMS ARE SIMILAR.

SECTION 10 (CONTINUED)

DESIGN INFORMATION FOR UNDER CONSTRUCTION FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	CATERPILLAR TRACTOR CO.
INSTALLATION LOCATION	MAPLETON, ILLINOIS
SOURCE CHARACTERISTICS	COAL (3.2% SULFUR)
SOURCE RATING	262,000 SCFM (TOTAL - 5 BOILERS)
	80,000 ACFM @ 350 F, FOR EACH OF 5 FGD SYSTEMS.
NUMBER OF SEPARATE FGD UNITS	5
NUMBER OF BOILERS BEING CONTROLLED	5
SOURCE CAPACITY	131 MW (EQUIVALENT); TOTAL - 5 BOILERS.
CONTROL SYSTEM VENDOR	FMC ENVIRONMENTAL EQUIPMENT
CONTROL PROCESS	DOUBLE ALKALI (CONCENTRATED)
NEW / RETROFIT	NEW
START-UP DATE	OCTOBER, 1979
	2 SYSTEMS WILL START UP IN 1979-1979 HEATING SEASON
	3 SYSTEMS AS OF YET HAVE NO FIRM START-UP SCHEDULE.
CONTROL SYSTEM STATUS	CONSTRUCTION
SO2 REMOVAL EFFICIENCY	90% (2000 PPM @ INLET)
SLUDGE OR BY-PRODUCT DISPOSAL	DEWATERED SLURRY TO LANDFILL
	60+% SOLIDS (CASO4) SLUDGE DIRECTLY TO LANDFILL.
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

AT THE MAPLETON, ILLINOIS PLANT, CATERPILLAR TRACTOR IS INSTALLING TWO NEW BOILER PLANTS WHICH WILL BE COMPLETED BY THE EARLY 1980'S. PLANS CALL FOR THE ERECTION OF EIGHT BOILERS, EACH RATED AT ABOUT 200,000LB/HR STEAM. THE TOTAL STEAM GENERATING CAPACITY WILL BE 1,650,000 LB/HR STEAM. THREE OF THESE BOILERS WILL BE COMPLETED BY THE 1978-79 HEAT SEASON. TWO MORE WILL COME ON-LINE DURING THE 1979-80 HEAT SEASON. THE START-UP DATES FOR THE OTHER THREE HAVE NOT YET BEEN DETERMINED. CATERPILLAR HAS AWARDED A CONTRACT TO FMC ENVIRONMENTAL EQUIPMENT TO PROVIDE CONCENTRATED-MODE DUAL ALKALI FGD SYSTEMS FOR ALL EIGHT BOILERS.

THERE ARE TWO CATERPILLAR FACILITIES AT MAPLETON, LOCATED NEXT TO EACH OTHER. THERE WILL BE FOUR BOILERS AT EACH FACILITY. EACH BOILER WILL HAVE A SEPARATE FGD SYSTEM. THE 4 FMC SYSTEMS AT EACH FACILITY WILL SHARE REGENERATION FACILITIES, VACUUM FILTER, AND SLUDGE DISPOSAL. EACH FGD TRAIN WILL BE TREATING APPROXIMATELY 80,000 ACFM @350 F.

SECTION 10 (CONTINUED)

DESIGN INFORMATION FOR UNDER CONSTRUCTION FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	CHANSLOR WESTERN OIL & DEV. CO
INSTALLATION LOCATION	BAKERSFIELD, CALIFORNIA
SOURCE CHARACTERISTICS	OIL (1.5% SULFUR)
SOURCE RATING	70,000 SCFM (TOTAL - 8 BOILERS) 310 MM BTU/HR (TOTAL - 8 BOILERS) 133,400 ACFM @ 550 F (TOTAL - 8 BOILERS)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	8
CONTROL SYSTEM VENDOR	FMC ENVIRONMENTAL EQUIPMENT
CONTROL PROCESS	DOUBLE ALKALI (CONCENTRATED)
NEW / RETROFIT	NEW
START-UP DATE	DECEMBER, 1978
CONTROL SYSTEM STATUS	CONSTRUCTION
SO2 REMOVAL EFFICIENCY	96% (710 PPM @ INLET)
WATER MAKE-UP	71 GPM
SLUDGE OR BY-PRODUCT DISPOSAL	DEWATERED SLURRY TO LANDFILL
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

OPERATING HISTORY

CHANSLOR-WESTERN HAS AWARDED THE CONTRACT TO FMC FOR THE DUAL ALKALI FGD SYSTEM, WHICH WILL GO ON STREAM IN DECEMBER, 1978. THE ABSORPTION TOWER WILL CONTAIN 4 DISC-AND-DONUT TRAYS, AND A CHEVRON DEMISTER.

SECTION 10 (CONTINUED)

DESIGN INFORMATION FOR UNDER CONSTRUCTION FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	GETTY OIL COMPANY
INSTALLATION LOCATION	BAKERSFIELD, CALIFORNIA
SOURCE CHARACTERISTICS	OIL (1.1% SULFUR)
SOURCE RATING	995,750 SCFM (TOTAL-72 BOILERS) 9 FGD SYSTEMS, EACH TREATING 200,000 ACFM @ 500 F
NUMBER OF SEPARATE FGD UNITS	9
NUMBER OF BOILERS BEING CONTROLLED	72
SOURCE CAPACITY	3600 MM BTU/HR, 495-MW EQUIVALENT (TOTAL-72 BOILERS) EACH BOILER RATED AT 42,000 LBS/HR STEAM
CONTROL SYSTEM VENDOR	PROPRIETARY DESIGN
CONTROL PROCESS	SODIUM CARBONATE SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	DECEMBER, 1978
CONTROL SYSTEM STATUS	CONSTRUCTION
SO2 REMOVAL EFFICIENCY	96% (70 PPM SO2 @ OUTLET)
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT AND DISCHARGE TO TAILINGS POND
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

GETTY OIL, BAKERSFIELD, CALIFORNIA IS PRESENTLY CONSTRUCTING 9 NEW FGD SCRUBBERS SUPPLIED BY KOCH ENGINEERING. EIGHT BOILERS MANUFACTURED BY STRUTHERS & C.E. NATCO WILL BE HEADERED INTO EACH SCRUBBER. EACH BOILER IS RATED AT 42,000 LBS/HR STEAM.

EACH SCRUBBER (33' HEIGHT X 18' DIAMETER) WILL EMPLOY 3 KOCH BUBBLE CAP TRAYS AND CLEANSE 200,000 ACFM @ 500 F INLET TEMPERATURE WITH A DESIRED EFFICIENCY OF 96%. THE INLET SO2 CONCENTRATION WILL BE APPROXIMATELY 600 PPM. DESIRED CONTROL PH WILL BE WITHIN THE RANGE OF 6.5 - 6.8 WITH SCRUBBER LIQUOR BEING RECIRCULATED AT 1000 GPM TO THE TOP TRAY. THE DESIGN L/G RATIO IS 9 GPM/1000 SCFM. EACH ABSORBER MODULE AND STACK WILL BE CONSTRUCTED OF 316L SS. THE DEMISTERS WILL BE KOCH FLEXIMESH DEMISTERS. THE F.D. FANS WILL BE 500 HP RADIAL TIP AMERICAN STANDARDS OR CHAMPION F.D. FANS.

THE WASTE SLUDGE WILL CONTINUOUSLY BE BLED OFF AT AN APPROXIMATE RATE OF 10 GPM TO A DISPOSAL TANK. THE SLUDGE WILL BE HAULED TO AN OPEN POND OR INJECTED INTO A DEEP WELL.

OPERATING HISTORY

3RD QUARTER-1978 OF THE 9 FGD SYSTEMS UNDER CONSTRUCTION, ONE WAS STARTED UP ON SEPT. 18, 1978 AND ANOTHER IS SCHEDULED FOR START-UP THE FIRST WEEK IN OCTOBER. THE LAST OF THE SYSTEMS IS SCHEDULED FOR START-UP BY MID FEBRUARY.

SECTION 10 (CONTINUED)

DESIGN INFORMATION FOR UNDER CONSTRUCTION FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	GREAT WESTERN SUGAR
INSTALLATION LOCATION	FREMONT, OHIO
SOURCE CHARACTERISTICS	COAL (1% SULFUR)
SOURCE RATING	60,000 SCFM (TOTAL - 2 BOILERS) 100,000 LB/HR STEAM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
CONTROL SYSTEM VENDOR	GREAT WESTERN SUGAR
CONTROL PROCESS	SODIUM CARBONATE SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	OCTOBER, 1978
CONTROL SYSTEM STATUS	CONSTRUCTION
SO2 REMOVAL EFFICIENCY	
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT AND DISCHARGE TO CITY SEWER
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE FGD SYSTEM CURRENTLY UNDER CONSTRUCTION AT THE FREMONT, OHIO PLANT OF GREAT WESTERN SUGAR HAS BEEN DESIGNED FOR BOTH SO2 AND PARTICULATE CONTROL. THE SYSTEM CONSISTS OF A VARIABLE THROAT VENTURI SCRUBBER WITH A SINGLE PASS, THREE STAGE CHEVRON DEMISTER.

A BLEEDOFF STREAM OF SCRUBBER EFFLUENT IS CONTINUOUSLY DISCHARGED TO A HOLDING POND FOR TREATMENT.

SECTION 10 (CONTINUED)

DESIGN INFORMATION FOR UNDER CONSTRUCTION FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	MOBIL OIL COMPANY
INSTALLATION LOCATION	BUTTONWILLOW, CALIFORNIA
SOURCE CHARACTERISTICS	OIL (1.1% SULFUR)
SOURCE RATING	42,000 SCFM (TOTAL - 7 BOILERS) 7 FGD SYSTEMS, EACH TREATING 11,400 ACFM @ 550F.
NUMBER OF SEPARATE FGD UNITS	7
NUMBER OF BOILERS BEING CONTROLLED	7
SOURCE CAPACITY	21 MW (EQUIVALENT); 175 MM BTU/HR (TOTAL - 7 BOILERS)
CONTROL SYSTEM VENDOR	HEATER TECHNOLOGY
CONTROL PROCESS	SODIUM CARBONATE SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	SEPTEMBER, 1978
CONTROL SYSTEM STATUS	CONSTRUCTION
SO2 REMOVAL EFFICIENCY	85% (500 PPM @ INLET)
WATER MAKE-UP	15 GPM; OIL FIELD WASTE WATER
SLUDGE OR BY-PRODUCT DISPOSAL	HOLDING POND FOR EVAPORATION INTERMITTENT BLOWDOWN TO WASTE DISPOSAL SITE.
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

MOBIL OIL HAS PURCHASED SEVEN HEATER TECHNOLOGY EDUCTOR SCRUBBER SYSTEMS FOR THE CONTROL OF SO2.

SECTION 10 (CONTINUED)

DESIGN INFORMATION FOR UNDER CONSTRUCTION FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	PHILLIP MORRIS, INC.
INSTALLATION LOCATION	CHESTER, VA.
SOURCE CHARACTERISTICS	COAL (1.7% SULFUR)
SOURCE RATING	39,000 SCFM (TOTAL - 1 BOILER)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	7
SOURCE CAPACITY	20 MW (EQUIVALENT); 237 MM BTU/HR
CONTROL SYSTEM VENDOR	FLAKT, INC.
CONTROL PROCESS	SODIUM CARBONATE SCRUBBING
NEW / RETROFIT	NEW
START-UP DATE	JANUARY, 1979
CONTROL SYSTEM STATUS	CONSTRUCTION
SO2 REMOVAL EFFICIENCY	90% (DESIGN MINIMUM)
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

PHILLIP MORRIS INC. OPERATES A 237 MM BTU/HR COAL-FIRED BOILER AT THEIR TOBACCO PROCESSING PLANT IN CHESTER, VIRGINIA. THE COAL, WHICH HAS APPROXIMATELY 1.7% SULFUR, IS MINED IN VIRGINIA, WEST VIRGINIA AND KENTUCKY.

FLAKT INC. IS CURRENTLY RETROFITTING A COMPLETE POLLUTION CONTROL SYSTEM WHICH IS SCHEDULED TO START-UP IN JANUARY 1979. THE BOILER FLUE GAS (88,900 ACFM @ 350F) WILL FIRST PASS THROUGH A COLD-SIDE ESP WITH A GUARANTEED MINIMUM EFFICIENCY OF 99.6%. THE FGD SYSTEM WILL USE SODIUM CARBONATE SCRUBBING LIQUOR AND IS DESIGNED TO TREAT TWO THIRDS OF THE GAS DISCHARGED FROM THE PRECIPITATOR; THE OTHER THIRD BEING USED FOR REHEAT. THE SCRUBBER IS DESIGNED FOR A MINIMUM SO2 REMOVAL EFFICIENCY OF 90%. AN OXIDATION TOWER WILL FOLLOW THE SCRUBBER TO OXIDIZE SODIUM SULFITE TO SODIUM SULFATE.

SECTION 10 (CONTINUED)

DESIGN INFORMATION FOR UNDER CONSTRUCTION FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	ST. JOE ZINC CO.
INSTALLATION LOCATION	MONACA, PENNSYLVANIA
SOURCE CHARACTERISTICS	COAL (2.5% - 4.5% SULFUR)
SOURCE RATING	104,000 SCFM (TOTAL - 1 BOILER)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	1
SOURCE CAPACITY	57 MW (NOMINAL PEAK CAPACITY)
CONTROL SYSTEM VENDOR	BUREAU OF MINES
CONTROL PROCESS	CITRATE PROCESS
NEW / RETROFIT	RETROFIT
START-UP DATE	DECEMBER, 1978
CONTROL SYSTEM STATUS	CONSTRUCTION
SO2 REMOVAL EFFICIENCY	90+%
SLUDGE OR BY-PRODUCT DISPOSAL	REGENERABLE - ELEMENTAL SULFUR PRODUCT
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

IN THE SUMMER OF 1977, CONSTRUCTION BEGAN AT MONACA, PA. ON A CITRATE PROCESS (BUREAU OF MINES) FGD SYSTEM FOR ONE OF THE TWO 60-MW (NOMINAL PEAK CAPACITY) BOILERS OF THE GEORGE F. WEATON POWER PLANT USED BY ST. JOE ZINC CO. TO GENERATE ELECTRICITY FOR A ZINC SMELTER. ST. JOE HAS A RECIPROCAL AGREEMENT WITH THE LOCAL UTILITY COMPANY, DUQUESNE LIGHT, WHEREBY ST. JOE CAN SELL UP TO 25-MW OF ITS TOTAL 120-MW CAPACITY TO DUQUESNE. IN RETURN ST. JOE CAN BUY SUFFICIENT POWER TO MAINTAIN SMELTING OPERATIONS IN THE EVENT OF AN EMERGENCY. IT IS THE FIRST SMALL COMMERCIAL SIZE EXPERIMENTAL CITRATE CONTROL SYSTEM BEING BUILT FOR SCRUBBING SULFUR DIOXIDE OUT OF COAL-FIRED POWER PLANT STACK GAS.

UNDER A $12.7 MILLION COST-SHARING AGREEMENT BETWEEN THE BUREAU AND ST. JOE, COSTS FOR TESTING THE CITRATE PROCESS FOR A FULL YEAR ARE BEING SHARED ABOUT 50-50. THE CITRATE PROCESS WAS DEVELOPED BY THE BUREAU IN THE 1960'S TO HELP CURB SULFUR DIOXIDE EMISSIONS FROM BASE METAL SMELTERS.

THE CITRATE PROCESS DERIVES ITS NAME FROM THE WATER SOLUTION OF SODIUM CITRATE AND CITRIC ACID USED TO ABSORB SO2 CONTAINED IN THE FLUE GAS. ADDING HYDROGEN SULFIDE TO THE CITRATE-SO2 SOLUTION PRECIPITATES SOLID ELEMENTAL SULFUR.

REFER TO FIGURE 14-13 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

3RD QUARTER-1978 ALL MAJOR EQUIPMENT HAS BEEN INSTALLED; INSTALLATION OF PIPING AND WIRING IS IN PROGRESS.

SECTION 10 (CONTINUED)

DESIGN INFORMATION FOR UNDER CONSTRUCTION FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	TEXACO INCORPORATED
INSTALLATION LOCATION	SAN ARDO, CALIFORNIA
SOURCE CHARACTERISTICS	OIL (1.7% SULFUR)
SOURCE RATING	117,000 SCFM (TOTAL - 9 BOILERS) 26,000 ACFM @ 600 F, FOR EACH OF 9 BOILERS.
NUMBER OF SEPARATE FGD UNITS	3
NUMBER OF BOILERS BEING CONTROLLED	9
SOURCE CAPACITY	58 MW (EQUIVALENT); 50 MM BTU/HR/BOILER
CONTROL SYSTEM VENDOR	DUCON COMPANY
CONTROL PROCESS	SODIUM HYDROXIDE SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	MARCH, 1979
CONTROL SYSTEM STATUS	CONSTRUCTION
SO2 REMOVAL EFFICIENCY	95% (1000 PPM @ INLET)
SLUDGE OR BY-PRODUCT DISPOSAL	SCRUBBER EFFLUENT DISPOSED OF IN WASTE WELLS
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

TEXACO SAN ARDO HAS CHOSEN TO PHASE OUT THE EXISTING CEILCOTE SCRUBBER SYSTEMS DUE TO LOW SO2 REMOVAL AND HIGH MAINTENANCE COST. AS THE FIRST STEP OF THE PHASE-OUT PROGRAM, 9 OF THE PRESENT 33 CEILCOTE SCRUBBERS ON THE 50 MM BTU/HR STEAM GENERATORS WILL BE REPLACED BY 3 DUCON CO. SCRUBBERS HEADERED IN PARALLEL. START-UP OF THE NEW EQUIPMENT IS SCHEDULED FOR MARCH 1979. THE NEXT STEP OF THE PHASE-OUT PROGRAM IS DEPENDENT ON THE PERFORMANCE OF THE DUCON SYSTEM.

A MAJOR PROBLEM OF THE PRESENT DESIGN HAS BEEN SCRUBBER FOULING BECAUSE OF HIGH ASH CONTENT IN IN THE FLUE GAS. EACH DUCON SCRUBBING UNIT WILL CONSIST OF A VENTURI FOR PARTICULATE REMOVAL FOLLOWED BY A HORIZONTAL 3-STAGE SPRAY ABSORBER (2 IN USE, 1 STAND-BY). IT IS HOPED THAT THE VENTURI DESIGN WILL ALLEVIATE THE FOULING PROBLEM.

ANOTHER DESIGN FEATURE OF THE DUCON SYSTEM ARE INDEPENDENT RECYCLE TANKS FOR VENTURI AND ABSORBER. FRESH SCRUBBING LIQUOR IS INTRODUCED AT THE ABSORBER, ENTERS THE ABSORBER RECYCLE TANK AND PARTIALLY OVERFLOWS TO THE VENTURI WHERE IT IS RECYCLED AND FINALLY DISPOSED OF IN ON-SITE WASTE WELLS. IN A COMPLETE CYCLE THE SCRUBBER LIQUOR IS RECYCLED 4 TIMES BEFORE DISPOSAL.

A VOLUME OF 78,000 ACFM @ 600 F WILL BE HANDLED BY EACH SCRUBBER. FURTHERMORE, EACH TRAIN CAN TREAT 50% OF THE LOAD AND CAN BE ISOLATED FROM THE FLUE GAS FLOW. IT IS HOPED THAT THIS SYSTEM DESIGN WILL YIELD SIGNIFICANTLY HIGHER AVAILABILITIES THAN THE DESIGN CURRENTLY IN USE. (FOR INFORMATION ON THE CEILITE DESIGN SEE TEXACO, SAN ARDO ENTRY IN SECTION 9 OF THIS REPORT.)

THE DUCON ABSORBER MODULE IS CONSTRUCTED OF FIBERGLASS WITH POLYPROPYLENE INTERNALS. THE VENTURI IS MADE OF 625 INCONEL. THE OVERALL DIMENSIONS OF THE SYSTEM ARE 11 FT X 20 FT X 30 FT. THE

SECTION 10 (CONTINUED)

DESIGN INFORMATION FOR UNDER CONSTRUCTION FGD SYSTEMS ON INDUSTRIAL BOILERS

TEXACO INCORPORATED; SAN ARDO, CALIFORNIA (CONTINUED)

SPRAY NOZZLES WILL BE NYLON OR STAINLESS STEEL. BOTH THE ABSORBER AND VENTURI RECYCLE PUMPS ARE MANUFACTURED BY GALLAGER. THEY ARE RUBBER-LINED AND SIZED 800 AND 1200 GPM RESPECTIVELY AT 40 HP. THERE ARE 2 GARDEN CITY FANS PER UNIT RATED AT 100 HP EACH.

DUCON HAS GUARANTEED 95% SO_2 REMOVAL EFFICIENCY.

OPERATING HISTORY

3RD QUARTER-1978 TEXACO HAS TAKEN DELIVERY ON ONE DUCON SYSTEM. DELIVERY ON THE OTHER UNITS IS EXPECTED SOON. THE UNITS ARE SCHEDULED TO START-UP WITH A NAOH SYSTEM. CONSIDERATION IS BEING GIVEN TO FUTURE CONVERSION TO NA_2CO_3.

SECTION 11

DESIGN INFORMATION FOR PLANNED FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	ARCO/POLYMERS, INC.
INSTALLATION LOCATION	MONACA, PENNSYLVANIA
SOURCE CHARACTERISTICS	COAL (3.0% SULFUR)
SOURCE RATING	236,000 SCFM (TOTAL - 3 BOILERS) 900,000 LB/HR STEAM @ 700 PSIG AND 700 F.
NUMBER OF SEPARATE FGD UNITS	3
NUMBER OF BOILERS BEING CONTROLLED	3
SOURCE CAPACITY	118 MW (EQUIVALENT); TOTAL - 3 BOILERS
CONTROL SYSTEM VENDOR	FMC ENVIRONMENTAL EQUIPMENT
CONTROL PROCESS	DOUBLE ALKALI (CONCENTRATED)
NEW / RETROFIT	RETROFIT
START-UP DATE	JUNE, 1980
CONTROL SYSTEM STATUS	PLANNED-CONTRACT AWARDED
SO2 REMOVAL EFFICIENCY	90% (1,800 PPM @ INLET)
PARTICULATE REMOVAL EFFICIENCY	99.5%
SLUDGE OR BY-PRODUCT DISPOSAL	DEWATERED SLURRY TO LANDFILL FLYASH ADDITION TO DEWATERED CASO3/CASO4 FILTER CAKE, THEN TO LANDFILL.
CONTROL SYSTEM COST	CAPITAL: $8,000,000 (1978). THIS TOTAL INSTALLED COST INCLUDES EQUIPMENT, INSTALLATION, DUCTWORK, STACK, PIPING, COST OF THE FGD SYSTEM, ENGINEERING, START-UP, AND TESTING. INSTRUMENTATION, ENGINEERING, AND OVERHEADS. OPERATING: PROJECTED COSTS ARE NOT YET AVAILABLE.

BACKGROUND INFORMATION

ARCO/POLYMERS, BEAVER VALLEY PLANT LOCATED NEAR MONACA, PENNSYLVANIA HAS AWARDED A CONTRACT IN JUNE 1978 TO FMC TO INSTALL THREE MULTI-STAGE DISC CONTACTOR SCRUBBERS. THE SYSTEM WILL UTILIZE THE FMC DOUBLE ALKALI PROCESS WITH THE SCRUBBERS SHARING A COMMON REGENERATION UNIT.

THREE BOILERS GENERATE PROCESS STEAM USED TO OPERATE A TURBINE WHICH GENERATES 18 TO 20 KVA (CAPICITY 35 KVA). THE STEAM RATE FOR EACH BOILER IS 300,000 LB/HR @ 700 PSIG AND 700 F. TOTAL HEAT INPUT IS 1100 MM BTU/HR. PULVERIZED COAL (3.0% SULFUR) IS THE FUEL USED WITH AN ASH CONTENT OF 15%. IT HAS A HEAT VALUE OF 12,000 BTU/LB @ 4-6% MOISTURE CONTENT. THE COST FOR THE COAL IS $8.84/TON.

HOPPERS ESP'S PRECLEAN THE FLUE GAS BEFORE IT ENTERS THE SCRUBBERS. THE INLET CONCENTRATION OF PARTICULATE TO THE ESP'S IS 5 GR/SCF. GAS ENTERING THE SCRUBBERS WILL HAVE AN SO2 CONCENTRATION OF APPROXIMATELY 1800 PPM. THE SCRUBBERS WILL BE CONSTRUCTED OF CARBON STEEL WITH CEILCOTE LININGS

ARCO/POLYMERS, INC.; MONACA, PENNSYLVANIA (CONTINUED)

(FLAKED GLASS LINING) AND THE MIST ELIMINATORS (1 FOR EACH SCRUBBER) ARE SINGLE STAGE CHEVRON PAD TYPE CONSTRUCTED OF PVC PLASTIC WITH PROVISIONS FOR A SECOND STAGE. EACH SCRUBBER WILL EXHAUST TO INDIVIDUAL INSULATED STACKS LINED WITH FRP. ASSOCIATED WITH EACH STACK IS A REHEATER USING STEAM HEATED AMBIENT AIR. THE SCRUBBERS WILL HANDLE 100% OF THE FLUE GASES WITH BY-PASS ONLY AVAILABLE FOR EMERGENCIES. THE L/G RATIO FOR THE SCRUBBERS IS APPROXIMATELY 10.

CALCIUM SULFATE (CASO4) WASTE WILL BE HAULED BY TRUCK TO A DISPOSAL SITE.

OPERATING HISTORY

3RD QUARTER-1978	CONSTRUCTION IS TO BEGIN IN SEPTEMBER 1978.

DESIGN INFORMATION FOR PLANNED FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	C.A.M.(CARBIDE-AMOCO-MONSANTO)
INSTALLATION LOCATION	HOUSTON, TEXAS
SOURCE CHARACTERISTICS	FUEL NOT SELECTED
SOURCE RATING	1,200,000 SCFM (1 BOILER) 600 MW (EQUIVALENT); 1 BOILER
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	1
CONTROL SYSTEM VENDOR	VENDOR NOT SELECTED
CONTROL PROCESS	PROCESS NOT SELECTED
NEW / RETROFIT	NEW
START-UP DATE	OCTOBER, 1983
CONTROL SYSTEM STATUS	PLANNED-CONSIDERING SO2 CONTROL
SO2 REMOVAL EFFICIENCY	NOT DETERMINED
SLUDGE OR BY-PRODUCT DISPOSAL	DISPOSAL TECHNIQUE NOT KNOWN

BACKGROUND INFORMATION

UNION CARBIDE, AMOCO, AND MONSANTO HAVE ENTERED INTO A JOINT VENTURE (C.A.M.) TO ERECT A COGENERATION FACILITY NEAR HOUSTON, TEXAS. THE 600-MW (EQUIVALENT) BOILER WILL PRODUCE ELECTRICITY AND PROCESS STEAM FOR THE NEARBY PLANTS OF THE THREE COMPANIES.

THE TYPE OF FUEL TO BE USED IS NOT FINALIZED. HOWEVER, IT IS A SURETY THAT AN FGD SYSTEM WILL BE REQUIRED. STARTUP FOR THE POWER GENERATING FACILITY IS SCHEDULED FOR LATE 1983.

3RD QUARTER-1978 THE SYSTEM IS STILL IN THE VERY EARLY STAGES OF DEVELOPMENT. STEARNS-ROGERS HAS BEEN CONTRACTED TO DO PRELIMINARY ENGINEERING AND AID IN THE CHOICE OF AN FGD SYSTEM AND VENDOR. AS OF THIS REPORT PERIOD, COAL TYPE HAS NOT BEEN CHOSEN AND A CONTROL SYSTEM OR SYSTEM VENDOR HAS NOT BEEN SELECTED.

SECTION 11 (CONTINUED)

DESIGN INFORMATION FOR PLANNED FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	CARBORUNDUM ABRASIVES
INSTALLATION LOCATION	BUFFALO, NEW YORK
SOURCE CHARACTERISTICS	COAL (2.2% SULFUR)
SOURCE RATING	30,000 SCFM (TOTAL - 2 BOILERS) 160,000 LBS/HR STEAM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	15 MW (EQUIVALENT)
CONTROL SYSTEM VENDOR	CARBORUNDUM ENVIR. SYS. LTD.
CONTROL PROCESS	LIME SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	
CONTROL SYSTEM STATUS	PLANNED-CONTRACT AWARDED
SO2 REMOVAL EFFICIENCY	95%
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT

BACKGROUND INFORMATION

AT THE CARBORUNDUM ABRASIVES PLANT IN BUFFALO, NEW YORK THERE ARE 4 COAL-FIRED BOILERS BURNING 2.2% SULFUR COAL WITH AN AVERAGE HEAT VALUE OF 13,000 BTU/LB. TWO OF THESE BOILERS ARE IDENTICAL AND HAVE A TOTAL STEAM GENERATING CAPACITY OF 160,000 LB/HR.

THE FLUE GASES FROM THE TWO BOILERS WILL BE CONTROLLED BY A VENTURI SCRUBBER (4 FT INLET, 13 IN THROAT, 13 FT HIGH) FOLLOWED BY A 6-STAGE SPRAY TOWER (8.5 FT DIA X 38 FT HIGH). THE FGD SYSTEM WAS DESIGNED BY CARBORUNDUM ENVIRONMENTAL SYSTEMS LTD., AND WILL HANDLE 40,000 ACFM, OR 100% OF THE FLUE GAS FROM BOTH BOILERS. LIME WILL BE USED AS THE SCRUBBING MEDIUM AND THE DESIGN SO2 REMOVAL EFFICIENCY IS 95%. THE SPRAY TOWER IS DESIGNED TO OPERATE AT 125 F WITH AN L/G RATIO OF 80 GAL/1000 ACF. THE MAXIMUM LIQUID FLOW RATE IS 3000 GPM. MAKE-UP WATER WILL BE FED TO THE TOP OF THE ABSORBER AT A RATE OF 45 GPM, WHILE A 30 GPM BLEED STREAM WILL FLOW FROM THE RECIRCULATION TANK DIRECTLY TO AN EXISTING TERTIARY WASTE TREATMENT FACILITY.

PARTICULATE REMOVAL OPERATING HISTORY

THE VENTURI AND ABSORBER MODULE WERE INSTALLED IN 1975. THE VENTURI WAS PUT INTO SERVICE FOR PARTICULATE REMOVAL AT THAT TIME USING WATER AS THE SCRUBBING MEDIUM. THE HIGH CHLORIDE CONTENT OF THE FLUE GAS HAS CAUSED SERIOUS CORROSION PROBLEMS. EFFLUENT FROM THE VENTURI HAS A PH OF 2.8. THE 316L SS VENTURI WILL BE REPLACED WITH A HASTELLOY UNIT BEFORE START-UP FOR SO2 REMOVAL. THE ABSORBER, ALSO 316L SS WILL BE LINED WITH HASTELLOY OR FRP. AN ACID-RESISTANT COATING WAS RECENTLY APPLIED TO THE STACK LINER.

SECTION 11 (CONTINUED)

DESIGN INFORMATION FOR PLANNED FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	CHEVRON U.S.A. INC.
INSTALLATION LOCATION	BAKERSFIELD, CALIFORNIA
SOURCE CHARACTERISTICS	OIL (1.1% SULFUR)
SOURCE RATING	146,000 SCFM (TOTAL - 12 BOILERS) 2 FGD SYSTEMS, EACH TREATING 150,000 ACFM @ 500F.
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	12
SOURCE CAPACITY	73 MW (EQUIVALENT); TOTAL - 12 BOILERS 600 MM BTU/HR (TOTAL - 12 BOILERS; 6 BOILERS/FGD SYSTEM)
CONTROL SYSTEM VENDOR	KOCH ENGINEERING
CONTROL PROCESS	SODIUM CARBONATE SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	APRIL, 1979
CONTROL SYSTEM STATUS	PLANNED-REQUESTING/EVALUATING BIDS
SO2 REMOVAL EFFICIENCY	90% (680 PPM @ INLET)
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT

BACKGROUND INFORMATION

A CONTRACT WAS AWARDED TO KOCH ENGINEERING TO CONSTRUCT THE TWO FGD SYSTEMS. THE DESIGN WILL BE SIMILAR TO EXISTING NA2CO3 SCRUBBING UNITS. ENGINEERING AND PURCHASING BEGAN IN SEPTEMBER WITH CONSTRUCTION SCHEDULED TO BEGIN IN JANUARY.

SECTION 11 (CONTINUED)

DESIGN INFORMATION FOR PLANNED FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	DUPONT, INC.
INSTALLATION LOCATION	GEORGIA
SOURCE CHARACTERISTICS	COAL (1.5% SULFUR)
SOURCE RATING	280,000 SCFM (TOTAL - 3 BOILERS)
	1,200,000 LB/HR STEAM (TOTAL - 3 BOILERS)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	3
SOURCE CAPACITY	140 MW (EQUIVALENT)
CONTROL SYSTEM VENDOR	VENDOR NOT SELECTED
CONTROL PROCESS	DOUBLE ALKALI
NEW / RETROFIT	NEW
START-UP DATE	1987
CONTROL SYSTEM STATUS	PLANNED-CONSIDERING SO2 CONTROL
SO2 REMOVAL EFFICIENCY	90%
SLUDGE OR BY-PRODUCT DISPOSAL	DEWATERED SLURRY TO LANDFILL

BACKGROUND INFORMATION

DUPONT INC. HAS 3 COAL-FIRED BOILERS, EACH RATED AT 400,000 LB/HR STEAM GENERATION. IT IS PLANNED THAT THE FGD SYSTEM CONTROL ONLY TWO OF THE BOILERS AT ANY GIVEN TIME; ONE BOILER WOULD ALWAYS BE ON A STANDBY STATUS. FLUE GAS FLOW WOULD BE CONTROLLED BY DAMPERS LOCATED ON EACH BOILER.

SECTION II (CONTINUED)

DESIGN INFORMATION FOR PLANNED FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	DUPONT, INC.
INSTALLATION LOCATION	TEXAS
SOURCE CHARACTERISTICS	COAL (0.5% SULFUR)
SOURCE RATING	320,000 SCFM (TOTAL - 2 BOILERS)
	1,600,000 LB/HR STEAM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	160 MW (EQUIVALENT): TOTAL - 2 BOILERS
CONTROL SYSTEM VENDOR	VENDOR NOT SELECTED
CONTROL PROCESS	LIMESTONE SCRUBBING
NEW / RETROFIT	NEW
START-UP DATE	1982
CONTROL SYSTEM STATUS	PLANNED-CONSIDERING SO2 CONTROL
SO2 REMOVAL EFFICIENCY	90%
SLUDGE OR BY-PRODUCT DISPOSAL	DEWATERED SLURRY TO LANDFILL

SECTION 11 (CONTINUED)

DESIGN INFORMATION FOR PLANNED FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	GRISSOM AIR FORCE BASE
INSTALLATION LOCATION	BUNKER HILL, INDIANA
SOURCE CHARACTERISTICS	COAL (0.9% - 4.6% SULFUR)
SOURCE RATING	32,060 SCFM (TOTAL - 3 BOILERS)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	3
SOURCE CAPACITY	16 MW (EQUIVALENT); TOTAL - 3 BOILERS
CONTROL SYSTEM VENDOR	VENDOR NOT SELECTED
CONTROL PROCESS	DOUBLE ALKALI (CONCENTRATED)
NEW / RETROFIT	1 NEW 2 RETRO
START-UP DATE	SEPTEMBER, 1979
CONTROL SYSTEM STATUS	PLANNED-REQUESTING/EVALUATING BIDS
SO2 REMOVAL EFFICIENCY	
SLUDGE OR BY-PRODUCT DISPOSAL	DEWATERED SLURRY TO LANDFILL
CONTROL SYSTEM COST	CAPITAL: $1,800,000 - $2,000,000 (1978). THIS IS THE PROJECTED TOTAL INSTALLED COST.

BACKGROUND INFORMATION

AT GRISSOM AIR FORCE BASE NEAR BUNKER HILL, INDIANA, THE AIR FORCE HAS INITIATED A PROJECT WHICH INCLUDES THE ERECTION OF A NEW 65,000 LB/HR COAL-FIRED BOILER AND AN FGD SYSTEM FOR THE NEW UNIT AND TWO EXISTING 40,000 LB/HR COAL-FIRED UNITS. THE AMOUNT OF CAPITAL ALLOCATED FOR THE EMISSIONS CONTROL SYSTEM IS IN THE $1.8 - $2.0 MILLION RANGE. THE NAVY IS THE MILITARY CONSTRUCTION AGENT FOR THE PROJECT. ARNOLD M. DIAMOND HAS THE OVERALL CONSTRUCTION CONTRACT AND FOSDICK AND HILMER (CINCINNATI) IS THE A-E FIRM FOR THE FGD PORTION OF THE PROJECT.

THE A-E FIRM HAS SPECIFIED A CONCENTRATED DOUBLE ALKALI SYSTEM FOR THE CONTROL APPROACH, AND AIR POLLUTION INDUSTRIES, INC. (AIRPOL) HAS TENTATIVELY BEEN SELECTED AS THE VENDOR. FLUE GAS FROM EACH BOILER WILL PASS THROUGH A MECHANICAL COLLECTOR. THE GAS FROM ALL THREE BOILERS WILL THEN BE MANIFOLDED TOGETHER AND PASS THROUGH TWO PARALLEL ABSORBER TRAINS, EACH TRAIN CAPABLE OF HANDLING 50% OF THE FLUE GAS. THE MAXIMUM FLOW RATE IS 80,373 ACFM @ 465 F.

THE BOILERS FIRE APPROXIMATELY 40% EXCESS AIR. COAL MAY RANGE FROM 0.9% - 4.6% SULFUR AND WILL HAVE AN AVERAGE HEATING VALUE OF 11,500 BTU/LB. THE A-E FIRM HAS SPECIFIED THAT THE MAXIMUM SO2 OUTLET CONCENTRATION WILL BE 1.2 LB/MM BTU, AND THE MAXIMUM PARTICULATE AT THE OUTLET WILL BE 0.171 LB/MM BTU.

THE AIRPOL SYSTEM, IF APPROVED, WILL CONSIST OF 2 PARALLEL TIA 55 VENTURI SCRUBBERS, EACH FOLLOWED BY A CYCLONIC SEPARATOR AND STUB STACK. THERE WILL BE A COMMON RECIRCULATION TANK MADE OF 316 STAINLESS STEEL AND TWO 600 GPM RUBBER-LINED RECIRCULATION PUMPS. THE L/G RATIO IS 15 GAL/1000 ACF, WITH A SLURRY INLET TEMPERATURE OF 135 F AND A PH OF BETWEEN 5 AND 7. RECIRCULATION

DESIGN INFORMATION FOR PLANNED FGD SYSTEMS ON INDUSTRIAL BOILERS

GRISSOM AIR FORCE BASE; BUNKER HILL, INDIANA (CONTINUED)

PIPES WILL BE MADE OF FRP.

A 100-200 GPM BLEED STREAM FROM THE RECIRCULATION TANK GOES TO A 316 SS LIME REACTION TANK WHERE THE SODIUM SULFITE/SULFATE IS REACTED WITH SLAKED LIME PRODUCING CALCIUM SULFATE AND REGENERATING THE SODIUM HYDROXIDE. FROM THE REACTION TANK THE MIXED SLURRY FLOWS TO A THICKENER/CLARIFIER, WHERE INSOLUBLE CALCIUM COMPOUNDS ARE SEPARATED FROM THE CLEAR OVERFLOW CONTAINING THE REGENERATED NAOH. THE CLARIFIER OVERFLOW IS RETURNED TO THE ABSORBER, WHILE THE UNDERFLOW IS REACTED ONCE AGAIN WITH LIME IN A PIPELINE MIXER TO PRECIPITATE ANY RESIDUAL SULFITE AS SULFATE. THE SLURRY IS THEN FILTERED IN A ROTARY FILTER, AND THE FILTRATE IS RETURNED TO THE REACTION TANK. THE FILTER CAKE WILL BE LANDFILLED. THE TANKS WILL BE MADE OF 316 SS AND THE PIPING OF FRP. THE LIME STORAGE TANK AND SLAKER WILL BE CARBON STEEL.

SECTION 11 (CONTINUED)

DESIGN INFORMATION FOR PLANNED FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	SHELL OIL COMPANY
INSTALLATION LOCATION	BAKERSFIELD, CALIFORNIA
SOURCE CHARACTERISTICS	OIL (1.1% SULFUR)
SOURCE RATING	99,000 SCFM (TOTAL - 8 BOILERS)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	8
SOURCE CAPACITY	400 MM BTU/HR (50 MM BTU PER BOILER)
CONTROL SYSTEM VENDOR	VENDOR NOT SELECTED
CONTROL PROCESS	PROCESS NOT SELECTED
NEW / RETROFIT	NEW
START-UP DATE	
CONTROL SYSTEM STATUS	PLANNED-CONSIDERING SO2 CONTROL
SO2 REMOVAL EFFICIENCY	94% (575 PPM SO2 @ INLET)
SLUDGE OR BY-PRODUCT DISPOSAL	DISPOSAL TECHNIQUE NOT KNOWN

SECTION 11 (CONTINUED)

DESIGN INFORMATION FOR PLANNED FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	SHELL OIL COMPANY
INSTALLATION LOCATION	TAFT, CALIFORNIA
SOURCE CHARACTERISTICS	OIL (1.1% SULFUR)
SOURCE RATING	25,000 SCFM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	0
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	100 MM BTU/HR (TOTAL)
CONTROL SYSTEM VENDOR	VENDOR NOT SELECTED
CONTROL PROCESS	PROCESS NOT SELECTED
NEW / RETROFIT	NEW
START-UP DATE	
CONTROL SYSTEM STATUS	PLANNED-CONSIDERING SO2 CONTROL
SO2 REMOVAL EFFICIENCY	98% (575 PPM SO2 @ INLET)
SLUDGE OR BY-PRODUCT DISPOSAL	DISPOSAL TECHNIQUE NOT KNOWN

SECTION 12

DESCRIPTION OF INDUSTRIAL BOILER FGD SYSTEMS NOT OPERATING

INSTALLATION NAME	BUNGE, INC.
INSTALLATION LOCATION	CAIRO, ILLINOIS
SOURCE CHARACTERISTICS	COAL (3% SULFUR)
SOURCE RATING	44,000 SCFM (TOTAL - 2 BOILERS) 81,400 ACFM @ 520 F
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	22 MW (EQUIVALENT); TOTAL - 2 BOILERS 180,000 LBS/HR STEAM (TOTAL)
CONTROL SYSTEM VENDOR	DRAVO CORP./NAT'L LIME ASS'N
CONTROL PROCESS	LIME SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	SEPTEMBER, 1977
CONTROL SYSTEM STATUS	INDEFINITELY SHUT DOWN
SO2 REMOVAL EFFICIENCY	94% (2700 PPM INLET)
SLUDGE OR BY-PRODUCT DISPOSAL	DEWATERED SLURRY TO LANDFILL
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

BUNGE PURCHASED THIS LIME SCRUBBING SYSTEM FOR TESTING PURPOSES. THE LEWIS SCRUBBER, WHICH IS A HORIZONTAL ROTARY VESSEL WITH INTERNAL CHAINS, PERFORMED VERY WELL DURING THE TEST (94 PERCENT SO2 REMOVAL). PRESENTLY, BUNGE IS USING LOW SULFUR COAL (.9 PERCENT) AND HAS NO PLANS TO RESTART FGD OPERATIONS.

SECTION 12 (CONTINUED)

DESCRIPTION OF INDUSTRIAL BOILER FGD SYSTEMS NOT OPERATING

INSTALLATION NAME	GREAT WESTERN SUGAR
INSTALLATION LOCATION	LONGMONT, COLORADO
SOURCE CHARACTERISTICS	COAL (0.7% SULFUR)
SOURCE RATING	SCFM-N/A
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
CONTROL SYSTEM VENDOR	GREAT WESTERN SUGAR
CONTROL PROCESS	AMMONIA-LADEN PROCESS WATER
NEW / RETROFIT	RETROFIT
START-UP DATE	OCTOBER, 1973
CONTROL SYSTEM STATUS	TERMINATED
SO2 REMOVAL EFFICIENCY	35% (300-400 PPM @ INLET)
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT AND DISCHARGE TO RIVER
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

SECTION 12 (CONTINUED)

DESCRIPTION OF INDUSTRIAL BOILER FGD SYSTEMS NOT OPERATING

INSTALLATION NAME	HARRIS MINING CO.
INSTALLATION LOCATION	SPRUCE PINE, NORTH CAROLINA
SOURCE CHARACTERISTICS	COAL (0.8% SULFUR)
SOURCE RATING	4,000 SCFM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	2 MW (EQUIVALENT); TOTAL - 2 BOILERS
CONTROL SYSTEM VENDOR	W.W. SLY MANUFACTURING CO.
CONTROL PROCESS	WATER SCRUBBING (NA,NH3 OPTN.)
NEW / RETROFIT	RETROFIT
START-UP DATE	1973
CONTROL SYSTEM STATUS	INDEFINITELY SHUT DOWN
SO2 REMOVAL EFFICIENCY	
PARTICULATE REMOVAL EFFICIENCY	96%
SLUDGE OR BY-PRODUCT DISPOSAL	DISPOSAL TECHNIQUE NOT KNOWN
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE FGD SYSTEM AT THE HARRIS MINING COMPANY LOCATED AT SPRUCE PINE, NORTH CAROLINA REMOVES FLY-ASH AND SULFUR DIOXIDE FROM THE FLUE GAS OF A COAL FIRED BOILER. THE SCRUBBER IS A W.W. SLY IMPINGENT TYPE SCRUBBER CONSTRUCTED OF 304 STAINLESS STEEL. THE BOILER IS RATED 1.9 MW (EQUIVALENT 200 BOILER HORSEPOWER). COAL COMPOSITION IS TYPICALLY 0.8% SULFUR AND 5% ASH. PRIMARY INTEREST IN FLUE GAS SCRUBBING IS IN FLYASH REMOVAL AND NO TESTS FOR SULFUR DIOXIDE REMOVAL EFFICIENCY HAVE-BEEN MADE.

OPERATING HISTORY

2ND QUARTER-1977 NO OPERATIONAL PROBLEMS HAVE BEEN REPORTED.

1ST QUARTER-1978 THIS PLANT HAS BEEN MOVED TO THE INACTIVE SYSTEMS FILE UNTIL SUCH TIME AS ACTUAL FGD OPERATIONS BEGIN. THE SCRUBBER IS EQUIPPED WITH ALKALI ADDITION CAPABILITY, BUT WITH THE LOW SULFUR COAL CURRENTLY BEING FIRED, NO ALKALI ADDITION OR PH CONTROL IS OCCURRING.

2ND QUARTER-1978 PLANT REPORTED NO CHANGE.

3RD QUARTER-1978 PLANT REPORTED NO CHANGE.

SECTION 12 (CONTINUED)

DESCRIPTION OF INDUSTRIAL BOILER FGD SYSTEMS NOT OPERATING

INSTALLATION NAME	QUALITY MILLS, INC.
INSTALLATION LOCATION	MT. AIRY, NORTH CAROLINA
SOURCE CHARACTERISTICS	OIL
SOURCE RATING	10,000 SCFM (TOTAL - 3 BOILERS)
NUMBER OF SEPARATE FGD UNITS	0
NUMBER OF BOILERS BEING CONTROLLED	3
SOURCE CAPACITY	5 MW (EQUIVALENT), 52,000 LB/HR STEAM: TOTAL - 3 BOILERS
CONTROL SYSTEM VENDOR	COMMERCIAL FABRICATION & MACH.
CONTROL PROCESS	WATER SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	MAY, 1970
CONTROL SYSTEM STATUS	TERMINATED
SO2 REMOVAL EFFICIENCY	47% (600-800 PPM @ INLET)
PARTICULATE REMOVAL EFFICIENCY	80%-95% (0.05-0.16 GRAIN/SCF @ INLET)
WATER MAKE-UP	40 GPM* OPEN LOOP
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT AND DISCHARGE TO CITY SEWER SCRUBBING LIQUOR DISCHARGED TO NEUTRALIZATION POND
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

SECTION 12 (CONTINUED)

DESCRIPTION OF INDUSTRIAL BOILER FGD SYSTEMS NOT OPERATING

INSTALLATION NAME	TRANSCO TEXTILES, INC.
INSTALLATION LOCATION	AUGUSTA, GEORGIA
SOURCE CHARACTERISTICS	FUEL OIL (2% MAX. SULFUR)
SOURCE RATING	50,000 ACFM
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	1
SOURCE CAPACITY	20 MW (EQUIVALENT)
CONTROL SYSTEM VENDOR	FMC ENVIRONMENTAL EQUIPMENT
CONTROL PROCESS	SODIUM CARBONATE SCRUBBING
NEW / RETROFIT	NEW
START-UP DATE	MARCH, 1975
CONTROL SYSTEM STATUS	INDEFINITELY SHUT DOWN
SO2 REMOVAL EFFICIENCY	80%-85% (610 LB/HR @ INLET)
WATER MAKE-UP	48 GPM* OPEN LOOP
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT AND DISCHARGE TO RIVER NA2SO3/SO4 LIQUOR DISCHARGED TO A HOLDING POND
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

SECTION 12 (CONTINUED)

DESCRIPTION OF INDUSTRIAL BOILER FGD SYSTEMS NOT OPERATING

INSTALLATION NAME	U.S. GYPSUM CORP.
INSTALLATION LOCATION	OAKMONT, PENNSYLVANIA
SOURCE CHARACTERISTICS	COAL
SOURCE RATING	19,300 SCFM (TOTAL - 4 BOILERS)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	4
CONTROL SYSTEM VENDOR	AIRPOL INDUSTRIES
CONTROL PROCESS	DOUBLE ALKALI (DILUTE)
NEW / RETROFIT	NEW
START-UP DATE	
CONTROL SYSTEM STATUS	NEVER STARTED-UP
SO2 REMOVAL EFFICIENCY	SUFFICIENT TO MEET REGULATION
PARTICULATE REMOVAL EFFICIENCY	MEETS CODE
WATER MAKE-UP	10 GPM (CLOSED LOOP)
SLUDGE OR BY-PRODUCT DISPOSAL	DEWATERED SLURRY TO LANDFILL SLUDGE TO POND FOR DRYING. THEN TO LANDFILL.
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

SECTION 13

INDUSTRIAL BOILER FGD COSTS

COMPANY LOCATION CAPACITY (SCFM)	PROCESS STATUS START-UP DATE	COST CAPITAL	 OPERATING
ALYESKA PIPELINE SERVICE CO. VALDEZ, ALASKA 50,000	SODIUM HYDROXIDE SCRUBBING OPERATIONAL 6/77		

PLANT PERSONNEL HAVE NOT SEPARATED OUT FGD SYSTEM COSTS FROM OVERALL PROJECT COSTS NOR DO THEY KEEP OPERATING COSTS FOR THE FGD SYSTEM.

AMERICAN THREAD CO. MARION, NORTH CAROLINA 18,500	CAUSTIC WASTE STREAM OPERATIONAL 1973	$138,000.	$16,300.

THE CAPITAL COST REPRESENTS TOTAL INSTALLED COST IN 1972 DOLLARS. THE OPERATING COST INCLUDES NEW FIBERGLASS LININGS IN DUCTWORK AND ON FANS AND OPERATING LABOR AND MATERIALS FOR 1977.

ARMCO STEEL MIDDLETOWN, OHIO 84,000	LIME SCRUBBING OPERATIONAL 1975	$74,000.	

THIS IS THE REPORTED CAPITAL COST IN 1975 DOLLARS.

BELRIDGE OIL CO. MCKITTRICK, CALIFORNIA 12,000	SODIUM HYDROXIDE SCRUBBING CONSTRUCTION 11/78	$125,000.	

THIS IS THE REPORTED CAPITAL COST IN 1978 DOLLARS.

BELRIDGE OIL CO. MCKITTRICK, CALIFORNIA 12,000	SODIUM HYDROXIDE SCRUBBING OPERATIONAL 7/78	$100,000.	

THIS IS THE REPORTED CAPITAL COST IN 1978 DOLLARS.

SECTION 13 (CONTINUED)

INDUSTRIAL BOILER FGD COSTS

COMPANY LOCATION CAPACITY (SCFM)	PROCESS STATUS START-UP DATE	COST CAPITAL	 OPERATING
BELRIDGE OIL COMPANY MCKITTRICK, CALIFORNIA 12,000	SODIUM HYDROXIDE SCRUBBING OPERATIONAL 6/78	$100,000.	
	THE CAPITAL COST INCLUDES THE SCRUBBER, RECYCLE TANK, STACK, DEMISTER, PIPING, DUCTWORK, AND INSTRUMENTATION IN 1978 DOLLARS.		
BUNGE, INC. CAIRO, ILLINOIS 44,000	LIME SCRUBBING INDEFINITELY SHUT DOWN 9/77	$1,000,000.	
	THE CAPITAL COST REPRESENTS THE TOTAL INSTALLED COST OF THE FGD SYSTEM, ENGINEERING, START-UP, AND TESTING IN 1977 DOLLARS.		
CANTON TEXTILES CANTON, GEORGIA 25,000	CAUSTIC WASTE STREAM OPERATIONAL 6/74	$74,000.	
	THE CAPITAL COST REPRESENTS THE TOTAL COST FOR THE INSTALLED SYSTEM, IN 1974 DOLLARS.		
CATERPILLAR TRACTOR CO. EAST PEORIA, ILLINOIS 210,000	DOUBLE ALKALI (CONCENTRATED) OPERATIONAL 4/78		
	NO ECONOMIC INFORMATION HAS BEEN SUPPLIED FOR THE CATERPILLAR FGD SYSTEMS.		
CATERPILLAR TRACTOR CO. JOLIET, ILLINOIS 67,000	DOUBLE ALKALI (DILUTE) OPERATIONAL 9/74		
	NO ECONOMIC INFORMATION HAS BEEN SUPPLIED FOR THE CATERPILLAR FGD SYSTEMS.		

SECTION 13 (CONTINUED)

INDUSTRIAL BOILER FGD COSTS

COMPANY LOCATION CAPACITY (SCFM)	PROCESS STATUS START-UP DATE	COST CAPITAL	 OPERATING
CATERPILLAR TRACTOR CO. MAPLETON, ILLINOIS 157,000	DOUBLE ALKALI (CONCENTRATED) CONSTRUCTION 10/78		
	NO ECONOMIC INFORMATION HAS BEEN SUPPLIED FOR THE CATERPILLAR FGD SYSTEMS.		
CATERPILLAR TRACTOR CO. MAPLETON, ILLINOIS 262,000	DOUBLE ALKALI (CONCENTRATED) CONSTRUCTION 10/79		
	NO ECONOMIC INFORMATION HAS BEEN SUPPLIED FOR THE CATERPILLAR FGD SYSTEMS.		
CATERPILLAR TRACTOR CO. MORTON, ILLINOIS 40,000	DOUBLE ALKALI (DILUTE) OPERATIONAL 1/78		
	NO ECONOMIC INFORMATION HAS BEEN SUPPLIED FOR THE CATERPILLAR FGD SYSTEMS.		
CATERPILLAR TRACTOR CO. MOSSVILLE, ILLINOIS 140,000	DOUBLE ALKALI (CONCENTRATED) OPERATIONAL 10/75		
	NO ECONOMIC INFORMATION HAS BEEN SUPPLIED FOR THE CATERPILLAR FGD SYSTEMS.		
CHANSLOR WESTERN OIL & DEV. CO BAKERSFIELD, CALIFORNIA 70,000	DOUBLE ALKALI (CONCENTRATED) CONSTRUCTION 12/78	$1,500,000.	
	THE CAPITAL COST INCLUDES THE SCRUBBER, LIQUOR REGENERATION EQUIPMENT, AND DUCTWORK IN 1978 DOLLARS.		

SECTION 13 (CONTINUED)

INDUSTRIAL BOILER FGD COSTS

COMPANY LOCATION CAPACITY (SCFM)	PROCESS STATUS START-UP DATE	COST CAPITAL	COST OPERATING
CHEVRON U.S.A. INC. BAKERSFIELD, CALIFORNIA 248,000	SODIUM CARBONATE SCRUBBING OPERATIONAL 7/78	$2,800,000.	$920,000.

THE CAPITAL COST IS IN 1978 DOLLARS. THIS REPRESENTS THE TOTAL INSTALLED COST OF THE FGD SYSTEM INCLUDING SITE PREPERATION. THE OPERATING COST INCLUDES ELECTRICITY, SODA ASH, AND MAINTENANCE (LABOR AND MATERIALS). THIS CORRESPONDS TO A 340 DAY YEAR AND APPROXIMATELY $900/DAY PER SCRUBBER IN 1978.

FIRESTONE TIRE AND RUBBER CO. POTTSTOWN, PENNSYLVANIA 8070	DOUBLE ALKALI (CONCENTRATED) OPERATIONAL 1/75	$163,000.	$60,000.

THE CAPITAL COST INCLUDES EQUIPMENT, ENGINEERING AND STARTUP. THE COST DOES NOT INCLUDE LABOR AND MATERIALS FOR ELECTRICAL SYSTEM, PIPING, OR STRUCTURAL AND FOUNDATIONS ERECTION IN 1974 DOLLARS. THE OPERATING COST INCLUDES CHEMICALS, LABOR, ELECTRICITY, DISPOSAL, MATERIALS, AND LAB WORK FOR 1977.

FMC (SODA ASH PLANT) GREEN RIVER, WYOMING 446,000	SODIUM CARBONATE SCRUBBING OPERATIONAL 5/76	$10,000,000.	

THIS TOTAL CAPITAL COST, IN 1975 DOLLARS, INCLUDES ESP AND FGD PURCHASE AND INSTALLATION COSTS.

GENERAL MOTORS CORPORATION DAYTON, OHIO 36,000	SODIUM HYDROXIDE SCRUBBING OPERATIONAL 9/74	$668,000.	

THE CAPITAL COST IS THE TOTAL INSTALLED COST FOR THE TWO FGD SYSTEMS, IN 1974 DOLLARS.

GENERAL MOTORS CORPORATION PARMA, OHIO 128,400	DOUBLE ALKALI (DILUTE) OPERATIONAL 3/74	$3,200,000.	$644,000.

THE OPERATING COST REPRESENTS $11.70/TON COAL.

SECTION 13 (CONTINUED)

INDUSTRIAL BOILER FGD COSTS

COMPANY LOCATION CAPACITY (SCFM)	PROCESS STATUS START-UP DATE	COST CAPITAL	 OPERATING
GENERAL MOTORS CORPORATION PONTIAC, MICHIGAN 107,300	SODIUM HYDROXIDE SCRUBBING OPERATIONAL 4/76	$600,000.	
	THE CAPITAL COST REPRESENTS THE TOTAL INSTALLED COST IN 1972 DOLLARS.		
GENERAL MOTORS CORPORATION ST. LOUIS, MISSOURI 64,000	SODIUM HYDROXIDE SCRUBBING OPERATIONAL 1972	$773,000.	$172,000.
	THE CAPITAL COST IS IN 1973 DOLLARS. THE OPERATING COST INCLUDES MAINTENANCE MATERIALS, LABOR AND ELECTRICITY IN 1976.		
GENERAL MOTORS CORPORATION TONOWANDA, NEW YORK 92,000	SODIUM HYDROXIDE SCRUBBING OPERATIONAL 6/75	$2,200,000.	
	THE CAPITAL COST IS IN 1974 DOLLARS.		
GEORGIA-PACIFIC PAPER CO. CROSSETT, ARKANSAS 220,000	CAUSTIC WASTE STREAM OPERATIONAL 1975	$275,000.	
	THE CAPITAL COST REPRESENTS THE ABSORBER COST ONLY AND IS IN 1974 DOLLARS.		
GETTY OIL COMPANY BAKERSFIELD, CALIFORNIA 72,000	SODIUM CARBONATE SCRUBBING OPERATIONAL 6/77	$400,000.	$390,000.
	THE CAPITAL COST INCLUDES THE ABSORBER MODULE, SODA ASH TANK, PUMPS, AND PIPING IN 1977 DOLLARS. IT DOES NOT INCLUDE THE STACK, DUCTING, ENGINEERING, OR OVERHEADS. THE OPERATING COST IS EQUIVALENT TO $0.16/MM BTU, INCLUDES THE COST FOR SODA ASH, ELECTRICITY, AND SCRUBBER MAINTENANCE, AND REPRESENTS A 340-DAY YEAR.		

SECTION 15 (CONTINUED)

INDUSTRIAL BOILER FGD COSTS

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COMPANY                      PROCESS                                        COST
LOCATION                     STATUS                              -------------------------
CAPACITY (SCFM)              START-UP DATE                       CAPITAL        OPERATING
---------------              -------------                       -------        ---------

GETTY OIL COMPANY            SODIUM CARBONATE SCRUBBING        $4,500,000.     $5,220,000.
BAKERSFIELD, CALIFORNIA      CONSTRUCTION
993,750                      12/78

                    THE CAPITAL COST INCLUDES COST OF SCRUBBER, SODA
                    ASH TANK, PIPING, AND PUMPS IN 1978 DOLLARS FOR
                    9 SCRUBBER SYSTEMS.  THE OPERATING COST INCLUDES
                    ELECTRICITY, SCRUBBER MAINTENANCE, AND SODA ASH,
                    IS BASED ON A 340-DAY YEAR, AND REPRESENTS
                    $0.16/MM BTU FOR 9 SCRUBBING UNITS.



GREAT SOUTHERN PAPER CO.     CAUSTIC WASTE STREAM                $600,000.
CEDAR SPRINGS, GEORGIA       OPERATIONAL
420,000                      1975

                    THE CAPITAL COST IS THE EQUIPMENT COST FOR THE TWO
                    SCRUBBER MODULES IN 1974 DOLLARS.



GREAT WESTERN SUGAR          AMMONIA-LADEN PROCESS WATER
BILLINGS, MONTANA            OPERATIONAL
60,000                       10/77

                    NO COST INFORMATION HAS BEEN SUPPLIED FOR THE
                    BILLINGS FGD SYSTEM.



GREAT WESTERN SUGAR          SODIUM CARBONATE SCRUBBING          $523,000.        $30,200.
FINDLAY, OHIO                OPERATIONAL
65,230                       10/74

                    THE CAPITAL COST IS THE TOTAL INSTALLED COST OF
                    THE FGD SYSTEM IN 1974 DOLLARS.  THE OPERATING
                    COST INCLUDES ELECTRICITY, MAINTENENCE, LABOR, AND
                    MATERIALS.
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SECTION 13 (CONTINUED)

INDUSTRIAL BOILER FGD COSTS

COMPANY LOCATION CAPACITY (SCFM)	PROCESS STATUS START-UP DATE	COST CAPITAL	COST OPERATING
GREAT WESTERN SUGAR FORT MORGAN, COLORADO 65,230	AMMONIA-LADEN PROCESS WATER OPERATIONAL 10/76	$707,000.	$88,200.
	THE CAPITAL COST IS THE TOTAL INSTALLED COST OF THE FGD SYSTEM IN 1976 DOLLARS. THE OPERATING COST INCLUDES ELECTRICITY, STEAM, MAINTENENCE, LAABOR, AND MATERIALS.		
GREAT WESTERN SUGAR FREEMONT, OHIO 40,000	SODIUM CARBONATE SCRUBBING CONSTRUCTION 10/78		
	NO COST INFORMATION HAS BEEN SUPPLIED FOR THE FREEMONT FGD SYSTEM.		
GREAT WESTERN SUGAR GERING, NEBRASKA 110,000	AMMONIA-LADEN PROCESS WATER OPERATIONAL 10/75	$643,000.	$34,600.
	THE CAPITAL COST IS THE TOTAL INSTALLED COST OF THE FGD SYSTEM IN 1975 DOLLARS. THE OPERATING COST INCLUDES ELECTRICITY, MAINTENENCE, LABOR, AND MATERIALS.		
GREAT WESTERN SUGAR GREELEY, COLORADO 25,000	AMMONIA-LADEN PROCESS WATER OPERATIONAL 10/75		
	NO COST INFORMATION HAS BEEN SUPPLIED FOR THE GREELEY FGD SYSTEM.		
GREAT WESTERN SUGAR LONGMONT, COLORADO SCFM-N/A	AMMONIA-LADEN PROCESS WATER TERMINATED 10/73		
	NO COST INFORMATION HAS BEEN SUPPLIED FOR THE LONGMONT FGD SYSTEM.		

SECTION 13 (CONTINUED)

INDUSTRIAL BOILER FGD COSTS

COMPANY LOCATION CAPACITY (SCFM)	PROCESS STATUS START-UP DATE	COST CAPITAL	 OPERATING
GREAT WESTERN SUGAR LOVELAND, COLORADO 121,800	AMMONIA-LADEN PROCESS WATER OPERATIONAL 10/73	$431,000.	$84,400.

THE CAPITAL COST REPRESENTS THE TOTAL INSTALLED COST FOR TWO SCRUBBERS, I.D. FANS, NEW BREECHING, AND WATER SYSTEM IN 1973 DOLLARS. THE OPERATING COST INCLUDES ELECTRICITY, STEAM, MAINTENENCE, LABOR, AND MATERIALS.

GREAT WESTERN SUGAR SCOTTS BLUFF, NEBRASKA 65,230	AMMONIA-LADEN PROCESS WATER OPERATIONAL 10/75	$523,000.	$30,200.

THE CAPITAL COST IS THE TOTAL INSTALLED COST OF THE FGD SYSTEM IN 1975 DOLLARS. THE OPERATING COST INCLUDES ELECTRICITY, STEAM, MAINTENENCE, LABOR, AND MATERIALS.

HARRIS MINING CO. SPRUCE PINE, NORTH CAROLINA 4,000	WATER SCRUBBING (NA,NH3 OPTN.) INDEFINITELY SHUT DOWN 1973	$31,000.	

THE CAPITAL COST IS THE TOTAL INSTALLED COST IN 1973 DOLLARS.

ITT RAYONIER, INC. FERNANDINA BEACH, FLORIDA 201,000	SODIUM HYDROXIDE SCRUBBING OPERATIONAL 1975	$500,000.	

THE CAPITAL COST IS FOR 2 SCRUBBERS, DUCTWORK, AND STACKS IN 1975 DOLLARS.

KERR-MCGEE CHEMICAL CORP. TRONA, CALIFORNIA 490,000	SODIUM CARBONATE SCRUBBING OPERATIONAL 6/78	$6,000,000.	

KERR-MCGEE SPENT $1.5 MM IN A PILOT PLANT FOR SEVERAL YEARS BEFORE AND DURING CONSTRUCTION OF THE NEW FACILITY. OUT OF THE $200 MM PROJECT COST, $16 MM OF THAT IS FOR POWER PLANT AND $6 MM IS FOR THE BOILER'S RELATED POLLUTION CONTROL COSTS.

SECTION 13 (CONTINUED)

INDUSTRIAL BOILER FGD COSTS

COMPANY LOCATION CAPACITY (SCFM)	PROCESS STATUS START-UP DATE	COST CAPITAL	 OPERATING
MEAD PAPERBOARD CO. STEVENSON, ALABAMA 100,000	SODIUM HYDROXIDE SCRUBBING OPERATIONAL 1975	$173,000.	$840,000.

THE CAPITAL COST REPRESENTS THE ORIGINAL EQUIPMENT AND INSTALLATION COST IN 1974. SINCE THEN, EXTENSIVE MODIFICATIONS HAVE BEEN REQUIRED. ANOTHER $173,000 WAS SPENT FOR REPAIRS AND UPGRADING IN 1976. OVER THE SCRUBBER PLANT LIFE, AN ADDITIONAL $136,000 HAS BEEN SPENT, INCLUDING:$ 35,000 (RUBBER LINERS), $54,000 (STAINLESS STEEL LINERS), AND $47,000 (GENERAL REPAIRS).
THE OPERATING COST INCLUDES $40,000/YR FOR OPERATING LABOR, $40,000/YR FOR MAINTENANCE LABOR, AND $760,000/YR FOR REAGENT (8526 TONS).

MINN-DAK FARMER'S COOPERATIVE WAHPETON, NORTH DAKOTA 160,000	AMMONIA SCRUBBING OPERATIONAL 6/77	$300,000.	

THE CAPITAL COST REPRESENTS THE TOTAL EQUIPMENT COST IN 1977 DOLLARS.

MOBIL OIL COMPANY BUTTONWILLOW, CALIFORNIA 42,000	SODIUM CARBONATE SCRUBBING CONSTRUCTION 9/78	$500,000.	

THE CAPITAL COST INCLUDES ABSORBER MODULES, RECYCLE TANKS, STACK, DEMISTERS, PUMPS, AND PIPING IN 1978 DOLLARS. IT DOES NOT INCLUDE CAUSTIC TANK, FEED PUMPS, OR FEED PIPES.

MOBIL OIL CORPORATION SAN ARDO, CALIFORNIA 182,000	SODIUM HYDROXIDE SCRUBBING OPERATIONAL 1974	$2,900,000.	$1,290,000.

THE CAPITAL COST REPRESENTS EQUIPMENT, INSTALLATION, PIPING, DUCTWORK, STACK, WATER TREATMENT FACILITY, AND INSTRUMENTATION IN 1978 DOLLARS.
THE OPERATING COST INCLUDES ELECTRICITY, CAUSTIC, LABOR, AND MAINTENANCE. IT DOES NOT INCLUDE INDIRECT (FIXED) COSTS. THE AVERAGE OPERATING COST FOR THE 22 SMALLER SYSTEMS IS $35,000/YR EACH, AND FOR THE 8 LARGER SYSTEMS IS $65,000/YR EACH.

SECTION 14 (CONTINUED)

INDUSTRIAL BOILER FGD COSTS

COMPANY LOCATION CAPACITY (SCFM)	PROCESS STATUS START-UP DATE	COST CAPITAL	 OPERATING
NEKOOSA PAPERS, INC. ASHDOWN, ARKANSAS 211,000	CAUSTIC SCRUBBING OPERATIONAL 2/76	$250,000.	

THE CAPITAL COST REPRESENTS THE EQUIPMENT COST IN 1975 DOLLARS.

COMPANY LOCATION CAPACITY (SCFM)	PROCESS STATUS START-UP DATE	COST CAPITAL	 OPERATING
PHILLIP MORRIS, INC. CHESTER, VA. 39,000	SODIUM CARBONATE SCRUBBING CONSTRUCTION 1/79		

NO COST INFORMATION IS AS YET AVAILABLE.

COMPANY LOCATION CAPACITY (SCFM)	PROCESS STATUS START-UP DATE	COST CAPITAL	 OPERATING
QUALITY MILLS, INC. MT. AIRY, NORTH CAROLINA 10,000	WATER SCRUBBING TERMINATED 5/70	$18,000.	

THIS IS THE TOTAL INSTALLED CAPITAL COST IN 1970 DOLLARS.

COMPANY LOCATION CAPACITY (SCFM)	PROCESS STATUS START-UP DATE	COST CAPITAL	 OPERATING
RICKENBACKER AIR FORCE BASE COLUMBUS, OHIO 55,000	LIMESTONE SCRUBBING OPERATIONAL 3/76	$2,200,000.	$207,000.

THE CAPITAL COST INCLUDES ADJACENT ELECTRICAL SUBSTATION, SLUDGE DISPOSAL, EXTERNAL FLUES, AND OTHER ATYPICAL EQUIPMENT IN 1975 DOLLARS. THE OPERATING COST REPRESENTS THE OVERALL 1977 COST FOR 35,000 TONS OF COAL. DURING THE 1977 U.S.E.P.A. DEMONSTRATION TEST, OPERATING COSTS WERE $5.61/TON OF COAL. THESE COSTS INCLUDE OPERATING AND MAINTENANCE, LABOR, POWER, WATER, MAINTENANCE PARTS, AND SLUDGE DISPOSAL, BUT DOES NOT INCLUDE DEPRECIATION.

SECTION 13 (CONTINUED)

INDUSTRIAL BOILER FGD COSTS

COMPANY LOCATION CAPACITY (SCFM)	PROCESS STATUS START-UP DATE	COST CAPITAL	 OPERATING
SHELLER GLOBE CORP. NORFOLK, VIRGINIA 8,000	SODIUM HYDROXIDE SCRUBBING OPERATIONAL 1975	$80,000.	

THE CAPITAL COST IS THE ESTIMATED REPLACEMENT COST IN 1978. AN ESTIMATED MAINTENANCE COST OF $160/MO WAS REPORTED (2 MAN-DAYS/MO).

ST. JOE ZINC CO. MONACA, PENNSYLVANIA 104,000	CITRATE PROCESS CONSTRUCTION 12/78	$12,700,000.	

THE CAPITAL COST IS IN 1977 DOLLARS AND IS BEING JOINTLY FUNDED BY ST. JOE ZINC, THE US EPA, AND THE U.S. BUREAU OF MINES.

ST. REGIS PAPER CO. CANTONMENT, FLORIDA 115,000	CAUSTIC SCRUBBING OPERATIONAL 1973	$100,000.	

THE CAPITAL COST IS FOR THE ABSORBER ONLY AND IS IN 1973 DOLLARS.

TEXACO INCORPORATED SAN ARDO, CALIFORNIA 366,000	SODIUM HYDROXIDE SCRUBBING OPERATIONAL 11/73		

NO ECONOMIC INFORMATION HAS AS YET BEEN PROVIDED BY TEXACO.

TEXACO INCORPORATED SAN ARDO, CALIFORNIA 117,000	SODIUM HYDROXIDE SCRUBBING CONSTRUCTION 3/79		

NO ECONOMIC INFORMATION HAS AS YET BEEN PROVIDED

BY TEXACO.

SECTION 13 (CONTINUED)

INDUSTRIAL BOILER FGD COSTS

COMPANY LOCATION CAPACITY (SCFM)	PROCESS STATUS START-UP DATE	COST CAPITAL	 OPERATING
TEXASGULF GRANGER, WYOMING 140,000	SODIUM CARBONATE SCRUBBING OPERATIONAL 9/76		
	NO ECONOMIC INFORMATION HAS AS YET BEEN PROVIDED BY TEXASGULF.		
TRANSCO TEXTILES, INC. AUGUSTA, GEORGIA 50,000	SODIUM CARBONATE SCRUBBING INDEFINITELY SHUT DOWN 3/75		
	NO ECONOMIC INFORMATION WAS MADE AVAILABLE.		
U.S. GYPSUM CORP. OAKMONT, PENNSYLVANIA 19,300	DOUBLE ALKALI (DILUTE) NEVER STARTED-UP		
	NO ECONOMIC INFORMATION WAS MADE AVAILABLE.		

SECTION 14

PROCESS DIAGRAMS FOR INDUSTRIAL BOILER FGD SYSTEMS

THIS SECTION CONTAINS 16 PROCESS FLOW DIAGRAMS FOR SELECTED FGD SYSTEMS INCLUDED IN THIS REPORT. EACH DIAGRAM IS IDENTIFIED BY THE NAME OF THE COMPANY AND THE CITY AND STATE IN WHICH IT IS LOCATED. INCLUDED WITH EACH DIAGRAM IS A STREAM FLOW CHARACTERISTICS CHART AND AN EQUIPMENT LIST.

THE STREAM FLOW CHARACTERISTICS CHART IDENTIFIES VARIOUS PARAMETERS OF EACH STREAM IN THE DIAGRAM. INFORMATION FOR A PARTICULAR STREAM CAN BE OBTAINED BY REFERRING TO DATA UNDER EACH NUMBER IN THE CHART. EACH STREAM IN THE DIAGRAM IS MARKED BY A NUMBER, CIRCUMSCRIBED BY A HEXAGON. BLANK SPACES INDICATE THAT DATA EITHER IS NOT YET AVAILABLE OR THAT THE CHARACTERISTIC DOES NOT APPLY FOR THAT PARTICULAR STREAM.

THE EQUIPMENT LIST IDENTIFIES EACH PIECE OF EQUIPMENT IN THE DIAGRAM BY A LETTER/NUMBER LABEL (E.G., T12). THIS LIST IDENTIFIES EACH PIECE OF EQUIPMENT BY NAME AND GIVES THE SIZE, MATERIAL OF CONSTRUCTION AND THE NUMBER OF SUCH ITEMS AT A PARTICULAR PLANT SITE. BLANK SPACES INDICATE THAT INFORMATION HAS NOT YET BEEN MADE AVAILABLE TO THIS REPORT.

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14-15	TEXACO, SAN ARDO, CALIFORNIA	164
14-16	TEXASGULF, GRANGER, WYOMING	165

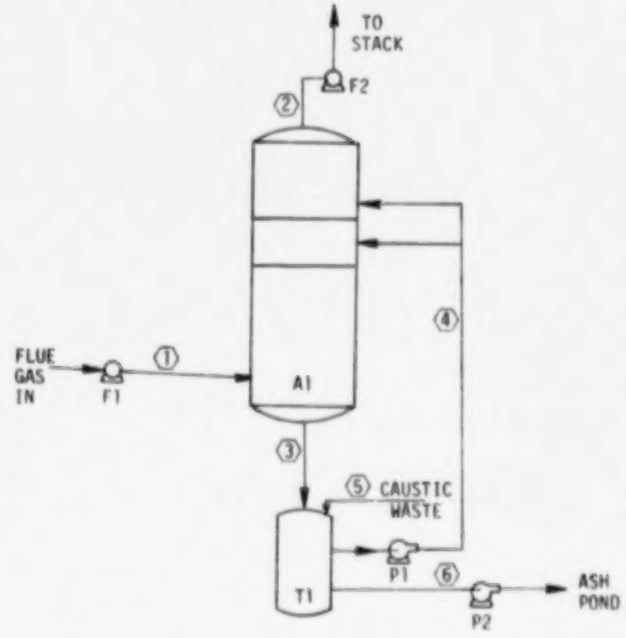

TO STACK
F2
②
A1
FLUE GAS IN
F1
①
③
④
⑤ CAUSTIC WASTE
T1
P1
⑥
P2
ASH POND

FIGURE 14-1. PROCESS FLOW DIAGRAM;
AMERICAN THREAD,
MARION, NORTH CAROLINA

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
A1	ABSORBER	10 DIA. x 12 HIGH	304SS, 316SS	2
F1	F.D. FAN	60 HP		2
F2	I.D. FAN	60 HP		2
P1	RECYCLE PUMP			
P2	WASTE PUMP			
T1	RECIRCULATION TANK	12 x 12 x 8 HIGH	3/8" C.S.	

STREAM NO.	①	②	③	④	⑤	⑥
RATE, lb/hr						
acfm x 1000	60	41.2				
gpm						
PARTICULATES, lb/hr						
SO_2, lb/hr						
TEMPERATURE, °F	400	130				
TOTAL SOLIDS, %						
SPECIFIC GRAVITY						
H_2O, lb/hr						
pH			2.5	8.5		
SULFITE, mg/l						
SULFATE, mg/l						
CHLORIDE, mg/l						

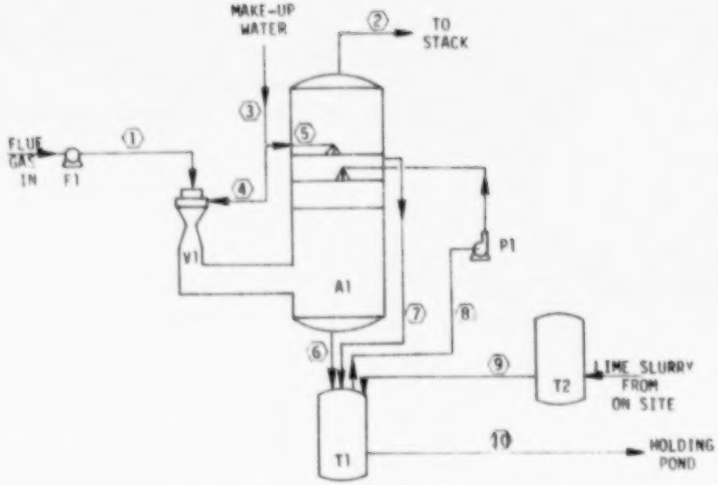

MAKE-UP WATER
②
TO STACK
③
⑤
①
FLUE GAS IN
F1
④
V1
A1
P1
⑦
⑧
⑥
⑨
T2
LIME SLURRY FROM ON SITE
⑩
T1
HOLDING POND

FIGURE 14-2. PROCESS FLOW DIAGRAM;
ARMCO STEEL,
MIDDLETOWN, OHIO

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
A1	ABSORBER	17 DIA.	C.S., FIBERGLASS LINED TRAYS, 316L SS	1
F1	F.D. FAN			1
P1	RECIRCULATION PUMP		RUBBER-LINED C.S.	1
T1	RECIRCULATION TANK	10,000 GAL.	RUBBER-LINED C.S.	1
T2	LIME SLURRY HOLD TANK			1
V1	VENTURI		316L SS	1

STREAM NO.	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
RATE, lb/hr										
acfm x 1000	140	83								
gpm			1600			3200		1600	300	1600
PARTICULATES, lb/hr		33								
SO_2, lb/hr										
TEMPERATURE, °F	425	71								
TOTAL SOLIDS, %										
SPECIFIC GRAVITY										
H_2O, lb/hr										
pH								7.0		
SULFITE, mg/l										
SULFATE, mg/l										
CHLORIDE, mg/l										

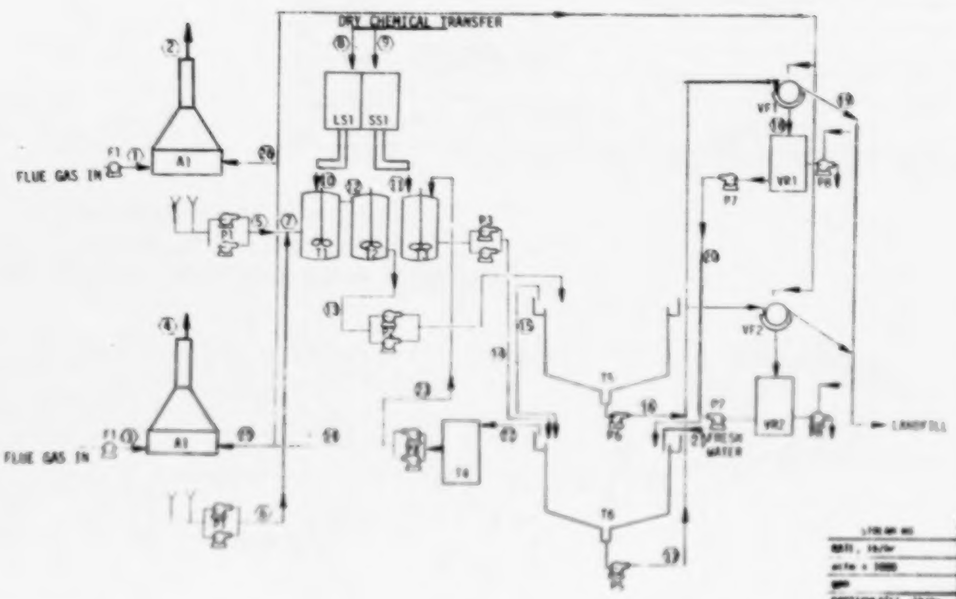

DRY CHEMICAL TRANSFER
FLUE GAS IN
FLUE GAS IN
F1
F1
A1
A1
LS1
SS1
T1
T2
T3
T4
T5
T6
P1
P3
P6
P7
P7
P8
VF1
VF2
VR1
VR2
FRESH WATER
LANDFILL

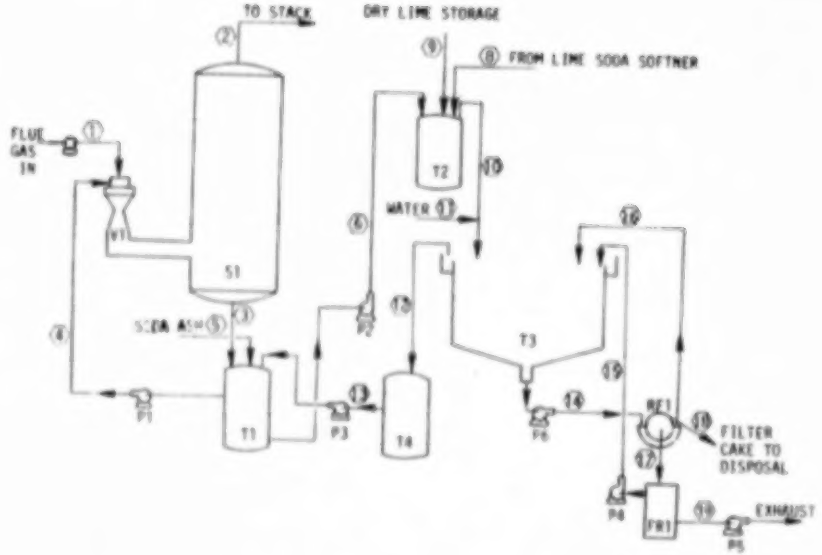
FIGURE 14-3. PROCESS FLOW DIAGRAM;
CATEPILLAR TRACTOR,
JOLIET, ILLINOIS

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
A1	ABSORBER		316 S.S.	2
F1	F.D. FAN			2
LS1	LIME STORAGE TANK		C.S.	1
P1	BLEED-OFF PUMPS			4
P2	LIME MIX TANK PUMPS			2
P3	SODA ASH MIX TANK PUMPS			2
P4	FEED WATER PUMPS			2
P5	SLUDGE PUMP			1
P6	SLUDGE PUMP			1
P7	FILTRATE PUMPS			2
P8	VACUUM PUMPS			2
SS1	SODA ASH STORAGE TANK		C.S.	1
T1	PRIMARY LIME MIX TANK		C.S.	1
T2	SECONDARY LIME MIX TANK		C.S.	1
T3	SODA ASH MIX TANK		C.S.	1
T4	SURGE TANK		C.S.	1
T5	THICKENER	50,000 GAL	C.S.	1
T6	CLARIFIER		C.S.	1
VF1	VACUUM FILTER		WET SURFACES 304 SS	1
VF2	VACUUM FILTER SPARE		WET SURFACES 304 SS	1
VR1	VACUUM RECEIVER		C.S.	1
VR2	VACUUM RECEIVER SPARE		C.S.	1

STREAM NO.	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬
RATE, lb/hr										1040	205		
acfm x 1000	57.5	61.9	66.0	33.2									
gpm													
PARTICULATES, lb/hr		22.9		15.0									
SO_2, lb/hr	265.0	32.8	261.1	23.5									
TEMPERATURE, °F	350	130	350	125									
TOTAL SOLIDS, %													
SPECIFIC GRAVITY													
H_2O, lb/hr													
pH													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													

STREAM NO.	⑭	⑮	⑯	⑰	⑱	⑲	⑳	㉑	㉒	㉓	㉔	㉕	㉖
RATE, lb/hr						5200							
acfm x 1000													
gpm								.6					
PARTICULATES, lb/hr													
SO_2, lb/hr													
TEMPERATURE, °F													
TOTAL SOLIDS, %			15-20	15-20		65							
SPECIFIC GRAVITY													
H_2O, lb/hr		32.0							12.0	12.0	12.0	12.0	12.0
pH													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													

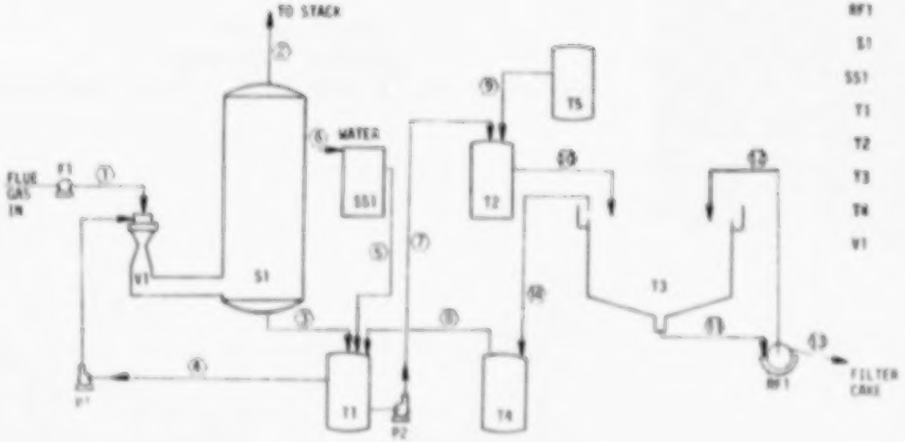

TO STACK
DRY LIME STORAGE
FROM LIME SODA SOFTNER
FLUE GAS IN
①
②
③
④
⑤
⑥
⑧
⑨
⑩
⑪
⑫
⑬
⑭
⑮
⑯
⑰
⑱
⑲
V1
S1
SODA ASH
T1
P1
P2
P3
T2
WATER
T4
T3
P6
RF1
FILTER CAKE TO DISPOSAL
P4
FR1
EXHAUST
P5

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
F1	F.D. FAN			1
FR1	FILTRATE RECEIVER			1
P1	RECIRCULATION PUMP			
P2	BLEED OFF PUMP			
P3	CAUSTIC PUMP			
P4	FILTRATE PUMP			
P5	EXHAUST PUMP			
P6	UNDERFLOW PUMP			
RF1	ROTARY FILTER			1
S1	SEPARATOR			4
T1	RECIRCULATION TANK			4
T2	LIME MIX TANK			
T3	THICKENER			
T4	SURGE TANK			
V1	VARIABLE THROAT VENTURI			4

FIGURE 14-4. PROCESS FLOW DIAGRAM; CATEPILLAR TRACTOR, MOSSVILLE, ILLINOIS

STREAM NO.	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰	⑱	⑲
RATE, lb/hr					292.1													2352	
acfm x 1000	40	28.4																	
gpm				345															
PARTICULATES, lb/hr	604.0	10.5																	
SO_2, lb/hr	440.1	23.4																	
TEMPERATURE, °F	413	159		130		130						120							
TOTAL SOLIDS, %																		60	
SPECIFIC GRAVITY				1.131		1.131						1.100							
H_2O, lb/hr																			
pH				6.40		6.40				8.3		8.4							
SULFITE, mg/l				24.2		24.2						13.7							
SULFATE, mg/l				86.9		86.9						70.8							
CHLORIDE, mg/l																			


FLUE GAS IN
F1
①
V1
S1
TO STACK
②
③
④
P1
⑤
⑥
WATER
SS1
⑦
T1
P2
⑧
T4
⑨
T5
T2
⑩
⑪
⑫
T3
⑬
RF1
FILTER CAKE

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
F1	F.D. FAN		C.S.	1
LS1	LIME STORAGE TANK			1
P1	RECIRCULATION PUMP		RUBBER-LINED CAST IRON	1
P2	LIME REACTOR PUMP		RUBBER-LINED CAST IRON	1
RF1	ROTARY FILTER		316L S.S.	1
S1	SEPARATOR	4.67 DIA x 7.17 HIGH	316L S.S.	1
SS1	SODA ASH STORAGE			1
T1	RECIRCULATION TANK		316L S.S.	1
T2	LIME REACTOR		C.S.	1
T3	THICKENER		C.S.	1
T4	SURGE TANK		C.S.	1
V1	DUAL THROAT VENTURI	.5-1.25 THROAT LENGTH	316L S.S.	1

FIGURE 14-5. PROCESS FLOW DIAGRAM FIRESTONE TIRE AND RUBBER, POTTSTOWN, PENNSYLVANIA

STREAM NO.	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬
MATL, lb/hr													100
acfm x 1000	13	10											
gpm				130	.003								
PARTICULATES, lb/hr	450	11.7											
SO_2, lb/hr	360	34.2											
TEMPERATURE, °F	300	130											
TOTAL SOLIDS, %													55
SPECIFIC GRAVITY													
H_2O, lb/hr													
pH													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													

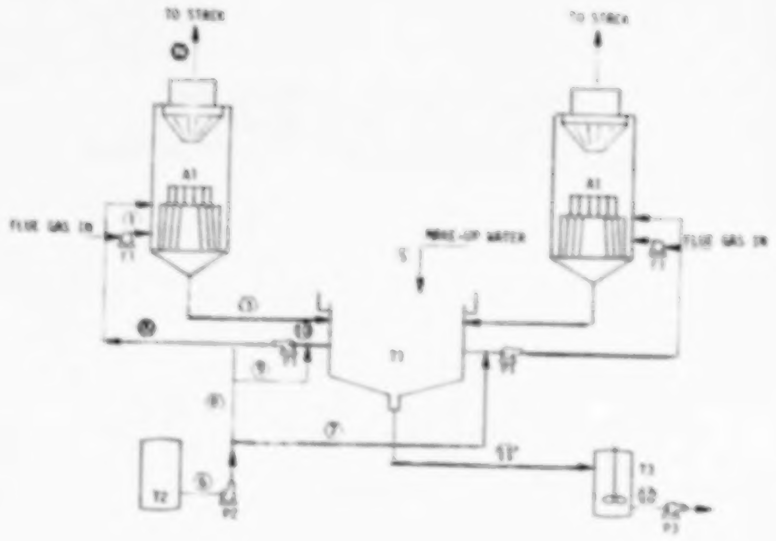

TO STACK
TO STACK
A1
A1
FLUE GAS IN
FLUE GAS IN
F1
F1
MAKE-UP WATER
T1
T2
T3
P1
P1
P2
P3
1
3
5
6
7
8
9
10
11
13

FIGURE 14-6. PROCESS FLOW DIAGRAM;
GENERAL MOTORS,
DAYTON, OHIO

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
A1	ABSORBER	6 DIA. x 10 HIGH	316L SS	2
F1	F.D. FAN	35,000 SCFM, 9 IN. W.G.	C.S.	2
P1	RECIRCULATION PUMP	200 GPM, 25 HEAD	RUBBER-LINED C.S.	3
P2	CAUSTIC PUMP	80 GPM	C.S.	1
P3	BLEED-OFF PUMP	50 GPM	RUBBER-LINED C.S.	2
T1	RECYCLE TANK	7.5 DIA. x 12 HIGH	316L SS	1
T2	CAUSTIC TANK	9 DIA. x 18 HIGH	C.S.	1
T3	BLEED-OFF TANK	6 DIA. x 6.5 HIGH	316L SS	1

STREAM NO.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
RAT'L, lb/hr													
acfm x 1000	45	10.6											
gpm			50	200	50								
PARTICULATES, lb/hr	55.3	8.1									35	35	
SO_2, lb/hr	111.5	16.4											
TEMPERATURE, °F	400	125											
TOTAL SOLIDS, %													
SPECIFIC GRAVITY												50	
H_2O, lb/hr													
pH				7.0									
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													

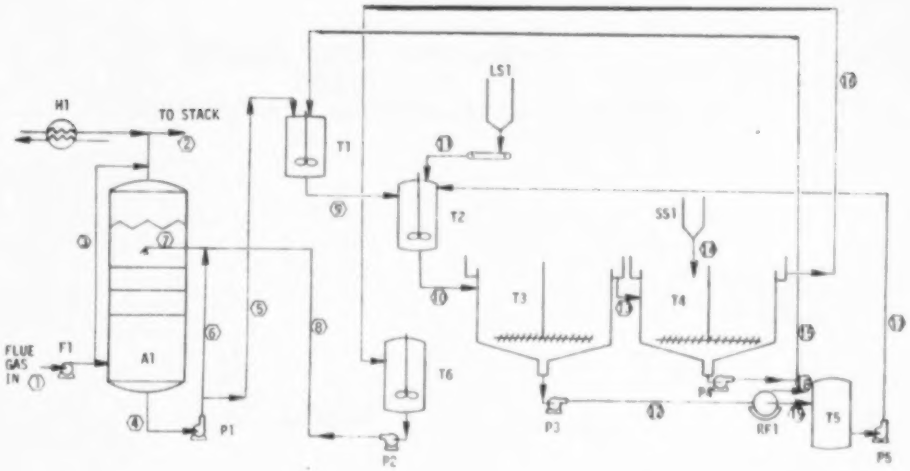


FIGURE 14-7. PROCESS FLOW DIAGRAM; GENERAL MOTORS, PARMA, OHIO

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
A1	ABSORBER	10.5 DIA. x 22.5 HIGH	316L SS	4
F1	F.D. FAN	200 HP, 12 IN. W.G.	C.S.	4
H1	REHEATER			4
P1	RECIRCULATION PUMP	2-750 GPM 2-550 GPM	C.S., RUBBER-LINED	4
P2	RECIRCULATION PUMP	700 GPM	RUBBER-LINED	3
P3	UNDERFLOW PUMP	100 GPM	RUBBER-LINED	2
P4	UNDERFLOW PUMP	25 GPM	RUBBER-LINED	2
P5	FILTRATE PUMP	300 GPM	RUBBER-LINED	2
RF1	ROTARY VACUUM FILTER	500 SQ. FT. AREA	C.S., POLYPROPYLENE CLOTH	2
LS1	LIME STORAGE	90 TON	C.S.	2
SS1	SODA ASH STORAGE	35 TON	C.S.	1
T1	CHEMICAL MIX TANK	5000 GAL	C.S.	1
T2	CHEMICAL MIX TANK	5000 GAL	C.S.	2
T3	CLARIFIER #1	60 DIA. x 14 HIGH		1
T4	CLARIFIER #2	60 DIA. x 14 HIGH		1
T5	FILTRATE TANK	4 DIA. x 7 HIGH	C.S.	1
T6	RECIRCULATION TANK	2-3700 GAL 2-3000 GAL	C.S., TAR COATING	4

STREAM NO.	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰	⑱	⑲
RATE, lb/hr																			
acfm x 1000	58.6	35.5																	
gpm										1200									
PARTICULATES, lb/hr	73.2	60.8																	
SO_2, lb/hr	244-397	41.5																	
TEMPERATURE, °F	550	152																	
TOTAL SOLIDS, %												15-20						50	
SPECIFIC GRAVITY																			
H_2O, lb/hr																			
pH																			
SULFITE, mg/l																			
SULFATE, mg/l																			
CHLORIDE, mg/l																			

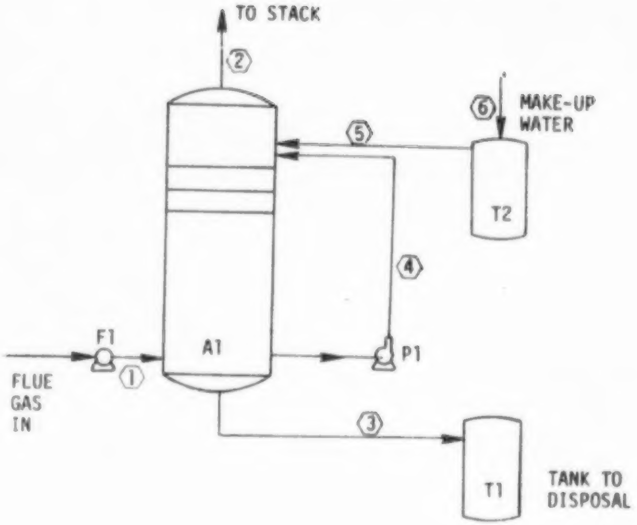

TO STACK
②
⑤
⑥
MAKE-UP WATER
T2
④
F1
A1
P1
FLUE GAS IN
①
③
T1
TANK TO DISPOSAL

FIGURE 14-8. PROCESS FLOW DIAGRAM;
GETTY OIL,
BAKERSFIELD, CALIFORNIA

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
A1	ABSORBER	13.5 DIA. x 35 HIGH	316L SS	9
F1	F.D. FAN	500 HP		9
P1	RECYCLE PUMP	40 HP		9
T1	DISPOSAL TANK			
T2	SODA ASH MIX TANK	42,000 GAL	1/4" C.S.	

STREAM NO.	①	②	③	④	⑤	⑥
MATL, lb/hr						
acfm x 1000	200	127				
gpm			10	1000		
PARTICULATES, lb/hr						
SO_2, lb/hr						
TEMPERATURE, °F	500	150				
TOTAL SOLIDS, %						
SPECIFIC GRAVITY						
H_2O, lb/hr						
pH				6.8		
SULFITE, mg/l						
SULFATE, mg/l						
CHLORIDE, mg/l						

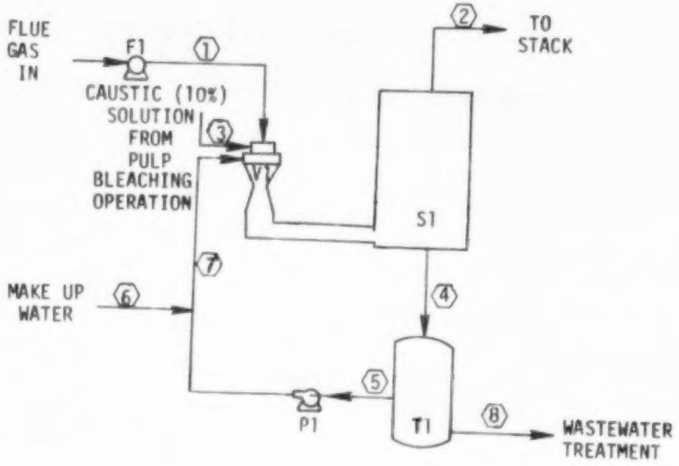

FLUE
GAS
IN
F1
①
CAUSTIC (10%)
SOLUTION
FROM
PULP
BLEACHING
OPERATION
③
②
TO
STACK
S1
⑦
MAKE UP
WATER
⑥
④
⑤
P1
T1
⑧
WASTEWATER
TREATMENT

FIGURE 14-9. PROCESS FLOW DIAGRAM;
ITT RAYONIER,
FERNANDINA BEACH, FLORIDA

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
F1	F.D. FAN	1035 HP		2
P1	RECIRCULATION PUMP	75 HP	316 SS	2
S1	SEPARATOR	16.5 DIA. x 38 HIGH	316L SS	2
T1	RECIRCULATION TANK			1
V1	VARIABLE THROAT VENTURI		316L SS	2

STREAM NO.	①	②	③	④	⑤	⑥	⑦	⑧
RATE, lb/hr								
acfm x 1000	165							
gpm			180		1470	160	1620	
PARTICULATES, lb/hr	1300	30						
SO_2, lb/hr								
TEMPERATURE, °F	460							
TOTAL SOLIDS, %								
SPECIFIC GRAVITY								
H_2O, lb/hr								
pH								
SULFITE, mg/l								
SULFATE, mg/l								
CHLORIDE, mg/l								

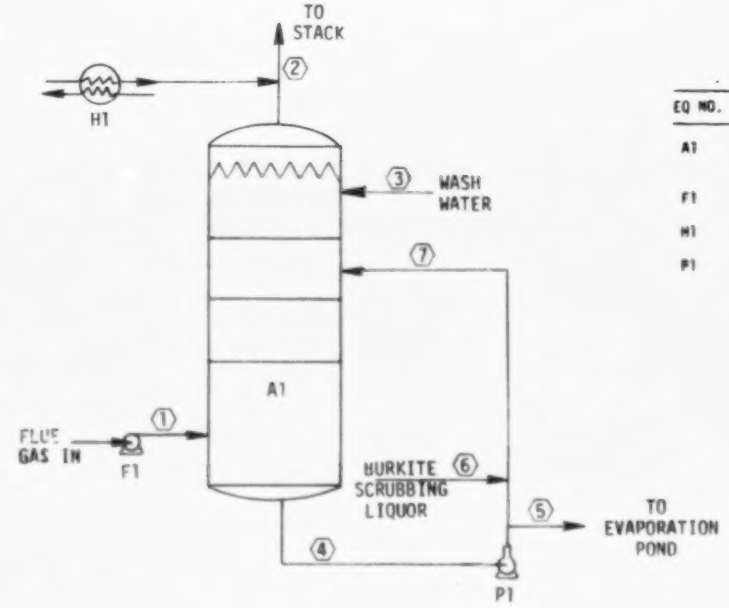

TO STACK
②
H1
③
WASH WATER
⑦
A1
①
FLUE GAS IN
F1
BURKITE SCRUBBING LIQUOR
⑥
⑤
TO EVAPORATION POND
④
P1

FIGURE 14-10. PROCESS FLOW DIAGRAM; KERR-McGEE, TRONA, CALIFORNIA

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
A1	ABSORBER	30 DIA. x 35 HIGH	C.S., FIBERGLASS LINED, 316L SS TRAYS	2
F1	F.D. FAN		C.S.	2
H1	REHEATER	50°F REHEAT	C.S.	2
P1	RECIRCULATION PUMP	125 GPM	C.S., RUBBER-LINED	2

STREAM NO.	①	②	③	④	⑤	⑥	⑦
RATE, lb/hr							
acfm x 1000	363	296					
gpm						125	
PARTICULATES, lb/hr							
SO_2, lb/hr							
TEMPERATURE, °F	320	175					
TOTAL SOLIDS, %							
SPECIFIC GRAVITY							
H_2O, lb/hr							
pH					6.0-6.5	6.0-6.5	6.0-6.5
SULFITE, mg/l							
SULFATE, mg/l							
CHLORIDE, mg/l							

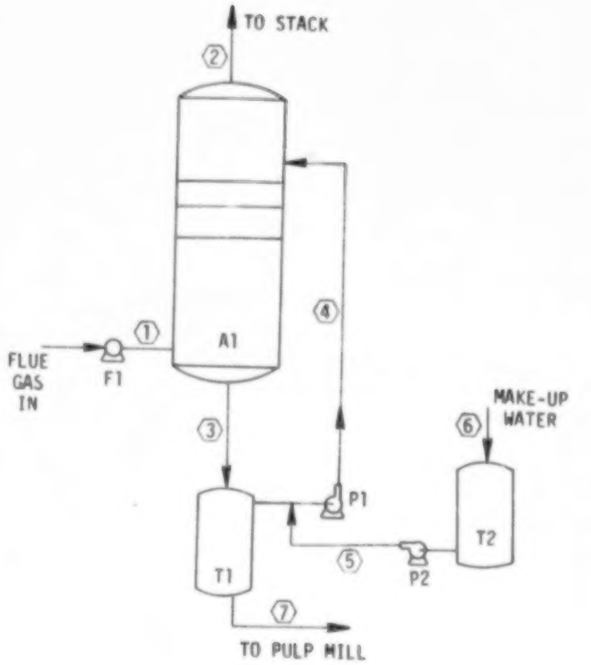

TO STACK
②
A1
①
FLUE GAS IN
F1
④
③
MAKE-UP WATER
⑥
P1
T2
T1
⑤
P2
⑦
TO PULP MILL

FIGURE 14-11. PROCESS FLOW DIAGRAM; MEAD PAPERBOARD, STEVENSON, ALABAMA

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
A1	ABSORBER		316 SS	1
F1	F.D. FAN			1
P1	RECYCLE PUMP			1
P2	CAUSTIC PUMP			1
T1	RECIRCULATION TANK		FIBERGLASS	1
T2	SODIUM CARBONATE TANK			1

STREAM NO.	①	②	③	④	⑤	⑥	⑦
RATE, lb/hr							
acfm x 1000	175	115					
gpm			1000	600	20-25	20-25	
PARTICULATES, lb/hr							
SO_2, lb/hr							
TEMPERATURE, °F	450	140					
TOTAL SOLIDS, %							
SPECIFIC GRAVITY			1.11-1.17				
H_2O, lb/hr							
pH				7.0-8.5			
SULFITE, mg/l							
SULFATE, mg/l							
CHLORIDE, mg/l							

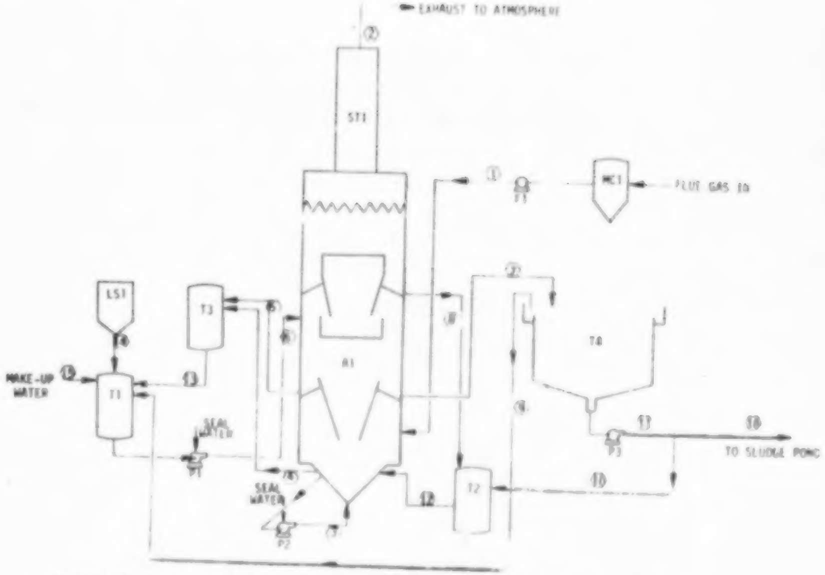

EXHAUST TO ATMOSPHERE
②
ST1
①
F1
MC1
FLUE GAS IN
LS1
T3
⑭
MAKE-UP WATER
⑮
T1
⑬
⑤
⑥
A1
⑧
②
T4
⑨
SEAL WATER
P1
⑧
SEAL WATER
P2
⑦
⑫
T2
⑪
⑩
P3
⑯
TO SLUDGE POND

FIGURE 14-12. PROCESS FLOW DIAGRAM; RICKENBACKER AFB, COLUMBUS, OHIO

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
A1	ABSORBER	12 DIA. x 61 HIGH	316L SS	1
F1	F.D. FAN	600 HP		1
LS1	LIME STORAGE	12 DIA. x 67 HIGH (120 TONS)	3/16" A-36 STEEL	1
MC1	MECHANICAL COLLECTOR			1
P1	RECIRCULATION PUMP		RUBBER LINED	1
P2	RECIRCULATION PUMP		RUBBER LINED	1
P3	UNDERFLOW PUMP		RUBBER LINED	1
ST1	STACK	5.5 DIA. x 20 HIGH	FRP	1
T1	LIME MIX TANK		316L SS	1
T2	2ND STAGE LEVEL TANK			1
T3	1ST STAGE LEVEL TANK			1
T4	CLARIFER	25 DIA.	WOOD	1

STREAM NO.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
RATE, lb/hr																
acfm x 1000	108															
gpm																
PARTICULATES, lb/hr	577.9	11.6														
SO_2, lb/hr	639.8	64.0														
TEMPERATURE, °F	475															
TOTAL SOLIDS, %						12.0				<40						
SPECIFIC GRAVITY																
H_2O, lb/hr																
pH						5.5-6.0			4.0			5.5				8.5
SULFITE, mg/l																
SULFATE, mg/l																
CHLORIDE, mg/l																

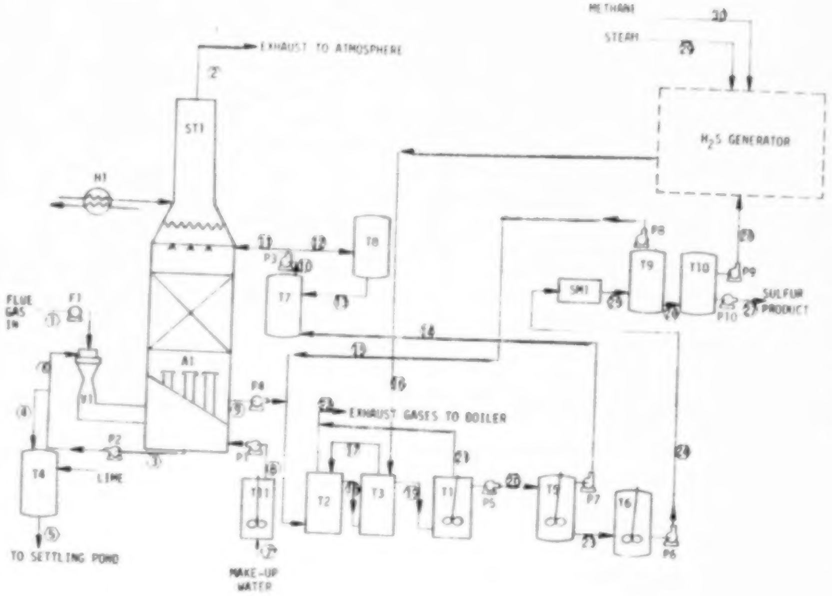

EXHAUST TO ATMOSPHERE
2
ST1
H1
FLUE GAS IN
F1
1
V1
6
4
A1
P2
3
T4
LIME
5
TO SETTLING POND
11
12
T8
P3
10
T7
13
14
15
16
P4
9
P1
18
T11
7
MAKE-UP WATER
22
EXHAUST GASES TO BOILER
17
T2
T3
19
T1
21
P5
20
T5
P7
23
T6
P6
24
SM1
25
T9
P8
26
T10
P9
28
P10
27
SULFUR PRODUCT
METHANE
STEAM
29
30
H_2S GENERATOR

FIGURE 14-13. PROCESS FLOW DIAGRAM;
ST. JOE ZINC CO.,
MONACA, PENNSYLVANIA
(Sheet 1 of 2)

EQUIPMENT LIST

EC NO.	NAME	SIZE, FEET	MATERIAL	NO
A1	ABSORBER	26 I.D. x 85 HIGH	C.S. FLAKEGLASS LINED	1
F1	F.D. FAN	234,000 ACFM, 1000 HP		1
F2	FLOTATION AIR BLOWER (NOT SHOWN)	921 PSI, PRESSURE DIFFERENTIAL	C.S	2
H1	REHEATER			1
P1	MAKE-UP PUMP	100 GPM, 27 PSI, 5 HP	HASTELLOY	1
P2	SCRUBBER RECYCLE PUMP	4500 GPM, 118 PSI, 250 HP	RUBBER-LINED CAST IRON	4
P3	LEAN SOLUTION PUMP	120 HP	CHLORIMET 3	1
P4	RICH CITRATE SOLUTION PUMP	40 HP	CHLORIMET 3	1
P5	SULFER SLURRY PUMP	64 GPM, 105 PSI, 20 HP	RUBBER-LINED HASTELLOY C	1
P6	SULFER SLURRY PUMP	64 GPM, 105 PSI, 20 HP	RUBBER-LINED HASTELLOY C	1
P7	LEAN SOLUTION PUMP	120 HP	CHLORIMET 3	1
P8	RICH CITRATE SOLUTION PUMP	40 HP	CHLORIMET 3	1
P9	SULFER TRANSFER PUMP	15 GPM, 72 PSI, 7.5 HP	CAST STEEL	1
P10	SULFER LOADING PUMP	50 GPM, 20 PSI, 3 HP	CAST STEEL	1
SM1	SULFER MELTER	4.11MM BTU/HR, ΔT=130°F	C.S. SHEEL HASTELLOY TUBES C-276	2
ST1	STACK	10 I.D. x 102 HIGH		1
T1	DIGESTER	12 I.D. x 18 HIGH	C.S., FLAKEGLASS LINED	1
T2	SULFER PRECIPITATION REACTOR	12.83 I.D. x 18.83 HIGH, 13,000 GAL	C.S. FLAKEGLASS LINED	1
T3	SULFER PRECIPITATION REACTOR	12.83 I.D. x 18.83 HIGH, 13,000 GAL	C.S. FLAKEGLASS LINED	1
T4	LIME NEUTRALIZATION TANK		-	1
T5	SULFER FLOTATION TANK	15 I.D. x 20 HIGH, 18,500 GAL	C.S. FLAKEGLASS - LINED	1
T6	SULFER SLURRY TANK	15 I.D. x 15 HIGH	C.S. FLAKEGLASS LINED	1
T7	CITRATE STORAGE TANK	28 I.D. x 30 HIGH	C.S., FLAKEGLASS LINED	1
T8	CRYSTALLIZER			1
T9	SULFER DECANER	65 PSIG @ 260°F	C.S., 1/8" HASTELLOY-C LINER	1
T10	STEAM HEATED SULFER STORAGE TANK	20 I.D. x 28 HIGH, 56,000 GAL	C.S.	1
T11	MAKE-UP TANK	5 I.D. x 7.5 HIGH	REINFORCED FIBERGLASS	1
T12	LEAN SOLUTION COOLER (NOT SHOWN)	5.4MM BTU/HR., 78 PSIG @ 131°F	PALLADIUM-STABILIZED TITANIUM	1
T13	VENTURI WASH WATER COOLER (NOT SHOWN)	19.8MM BTU/HR., 96 PSIG	PALLADIUM-STABILIZED TITANIUM	1
V1	VENTURI	10 DIA. x 45 HIGH	C.S., NOZZLE OF INCONEL 625, ACID PROOF BRICK LINED OVER RUBBER MEMBRANE	1
	H_2S GENERATOR	825 SCFM @ 45 PSIG, 300°F	S.S. SHELLS	1

STREAM NO.	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬
RATE, lb/hr													
acfm x 1000	234.0	156.											
gpm						16000	100				4200		
PARTICULATES, lb/hr													
SO_2, lb/hr													
TEMPERATURE, °F	300	120	120			112					123		
TOTAL SOLIDS, %													
SPECIFIC GRAVITY													
H_2O, lb/hr													
pH										4.5	4.5	4.5	
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													

STREAM NO.	⑭	⑮	⑯	⑰	⑱	⑲	⑳	㉑	㉒	㉓	㉔	㉕	㉖	㉗	㉘	㉙	㉚	㉛	㉜
RATE, lb/hr														1292					
acfm x 1000																			
gpm					1300	1300				130	64	130		50	15				
PARTICULATES, lb/hr																			
SO_2, lb/hr																			
TEMPERATURE, °F	121	120			131	131					131	260	260						
TOTAL SOLIDS, %										10									
SPECIFIC GRAVITY																			
H_2O, lb/hr																			
pH																			
SULFITE, mg/l																			
SULFATE, mg/l																			
CHLORIDE, mg/l																			

FIGURE 14-13. (Sheet 2 of 2)

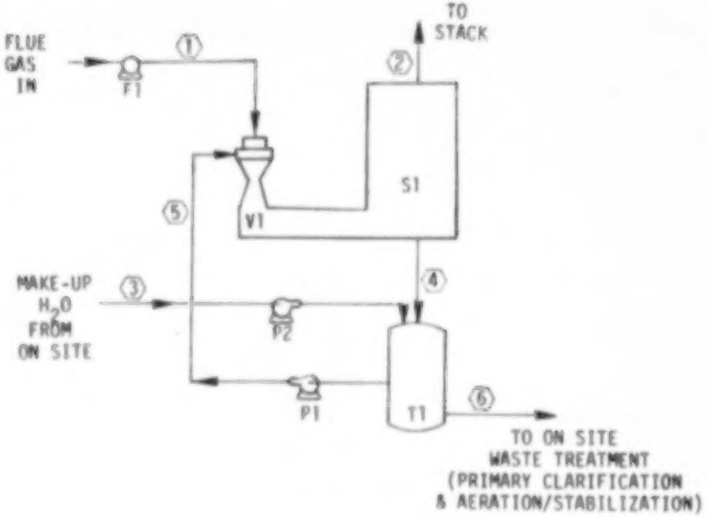
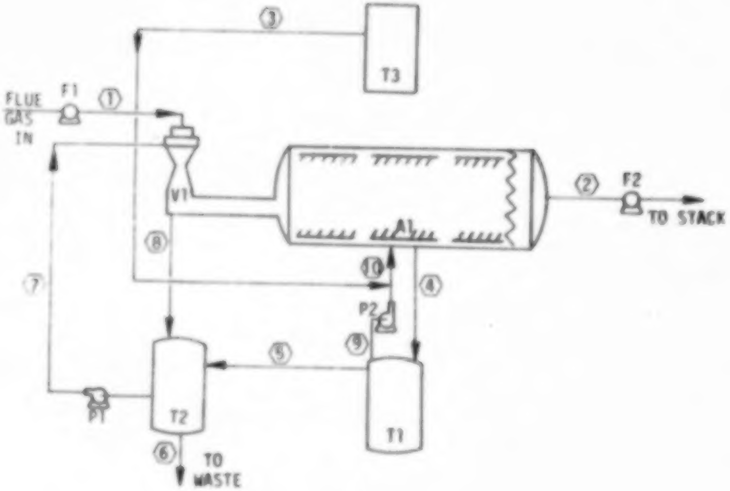

FLUE GAS IN
F1
①
TO STACK
②
S1
V1
⑤
MAKE-UP H$_2$O FROM ON SITE
③
P2
④
P1
T1
⑥
TO ON SITE WASTE TREATMENT (PRIMARY CLARIFICATION & AERATION/STABILIZATION)

FIGURE 14-14. PROCESS FLOW DIAGRAM; ST. REGIS PAPER; CANTONMENT, FLORIDA

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
F1	F.D. FAN			1
P1	RECIRCULATION PUMP			1
P2	MAKE-UP PUMP			1
S1	SEPARATOR		316L SS	1
T1	RECIRCULATION TANK	4000 GAL	304 SS	1
V1	VENTURI		316L SS	1

STREAM NO.	①	②	③	④	⑤	⑥
RATE, lb/hr						
acfm x 1000	175					
gpm			200-250			
PARTICULATES, lb/hr	400	22				
SO$_2$, lb/hr						
TEMPERATURE, °F	425					
TOTAL SOLIDS, %						
SPECIFIC GRAVITY						
H$_2$O, lb/hr						
pH			9.0			
SULFITE, mg/l						
SULFATE, mg/l						
CHLORIDE, mg/l						



EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
A1	ABSORBER	11 x 20 x 30	FIBERGLASS SHELL POLYPROPYLENE INTERNALS	9
F1	F.D. FAN	100 HP	FIBERGLASS REINFORCED PLASTIC	9
F2	I.D. FAN	100 HP		9
P1	RECYCLE PUMP	40 HP, 1200 GPM		9
T1	ABSORBER RECYCLE TANK		M.S.	9
T2	VENTURI RECYCLE TANK		M.S.	9
T3	CAUSTIC HOLD TANK		M.S.	9
V1	VENTURI		625 INCONEL	9

FIGURE 14-15. PROCESS FLOW DIAGRAM;
TEXACO
SAN ARDO, CALIFORNIA

STREAM NO.	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
RATE, lb/hr										
acfm x 1000	234	136.8								
gpm							1200			800
PARTICULATES, lb/hr										
SO_2, lb/hr										
TEMPERATURE, °F	600	160								
TOTAL SOLIDS, %										
SPECIFIC GRAVITY										
H_2O, lb/hr										
pH										
SULFITE, mg/l										
SULFATE, mg/l										
CHLORIDE, mg/l										

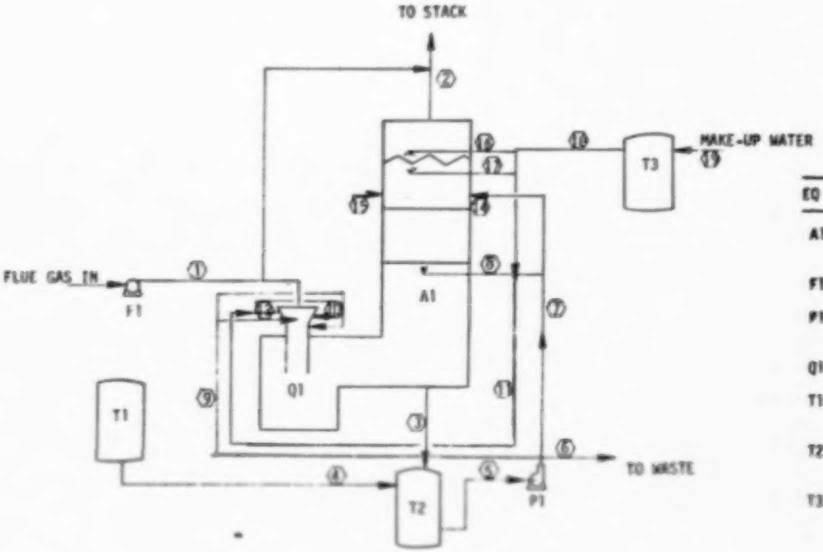

TO STACK
②
FLUE GAS IN
F1
①
A1
Q1
T1
T2
T3
P1
MAKE-UP WATER
⑲
TO WASTE
③
④
⑤
⑥
⑦
⑧
⑨
⑩
⑪
⑫
⑬
⑭
⑮
⑯
⑰
⑱

FIGURE 14-16. PROCESS FLOW DIAGRAM; TEXASGULF, GRANGER, WYOMING

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
A1	ABSORBER	15 DIA. x 20.5 HIGH	316L SS TRAYS INCONEL 625	1
F1	F.D. FAN			
P1	RECIRCULATION PUMP	550 GPM @ 15 PSIG		2
Q1	QUENCHER			1
T1	LIQUOR HEAD TANK			1
T2	RECIRCULATION TANK			1
T3	HEAD TANK			1

STREAM NO.	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰	⑱	⑲
RATE, lb/hr				3360-7140		15000-23220													
acfm x 1000	156.1	121.6																	
gpm			1023				700	300	300		45-116	45-66	0-50	200	200	100	15	45-116	60-9
PARTICULATES, lb/hr																			
SO_2, lb/hr																			
TEMPERATURE, °F	350	120				120													
TOTAL SOLIDS, %				30															
SPECIFIC GRAVITY																			
H_2O, lb/hr																			
pH																			
SULFITE, mg/l																			
SULFATE, mg/l																			
CHLORIDE, mg/l																			